AERONAUTICAL ENGINEERING REVIEW

DECEMBER 1948

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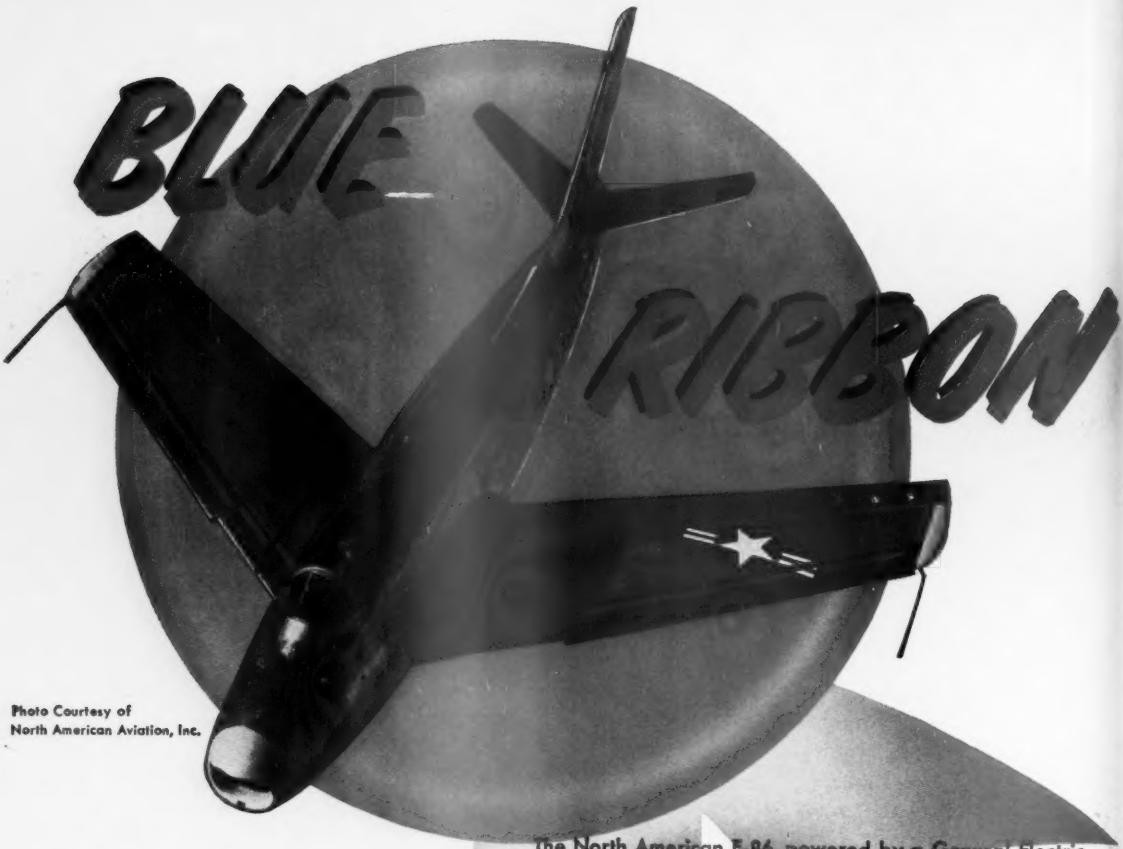

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North American Aviation, Inc.

The North American F-86, powered by a General Electric TG-190 (USAF Type J47) turbo-jet engine, is the "blue ribbon" winner of the new official world speed record of 670.981 miles an hour.

Piloted by veteran ace Major Richard L. Johnson, the turbo-jet plane bettered its own unofficial record of 669.75 mph set at the National Air Races at Cleveland. The F-86 was completely armed and carried a full complement of ammunition. The new record was announced on Air Force Day by General Hoyt S. Vandenberg, Chief of Staff of the Air Force.

The TG-190 power plant of the super-streamlined F-86, was developed and produced by G-E's Aircraft Gas Turbine Divisions at Lynn, Mass. The former speed record of 650.796 miles per hour was set by a Navy Douglas D-558 "Skystreak" propelled by the General Electric designed TG-180.

General Electric research and engineering works continuously to improve existing products and to devise new means to assist its associates in the aviation industry. G-E leadership in the development and production of engineered systems and precision products for aircraft is available to you by contacting your nearest G-E office. *Apparatus Department, General Electric Company, Schenectady, New York.*

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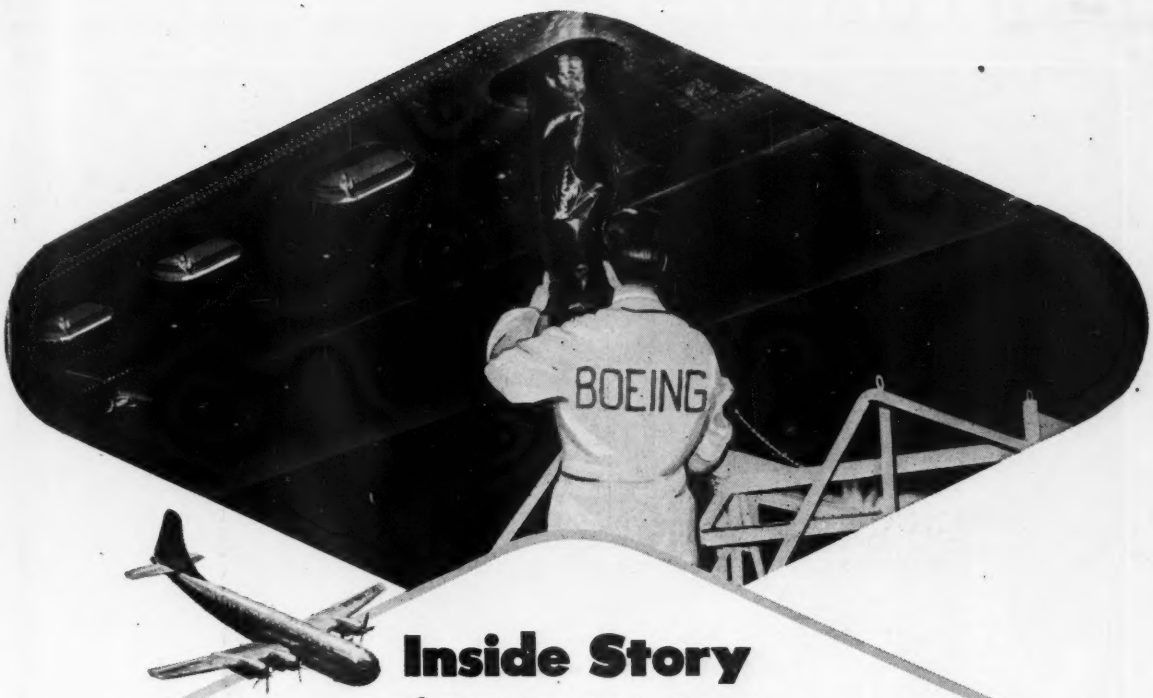


Inside Story

of Stratocruiser's Range

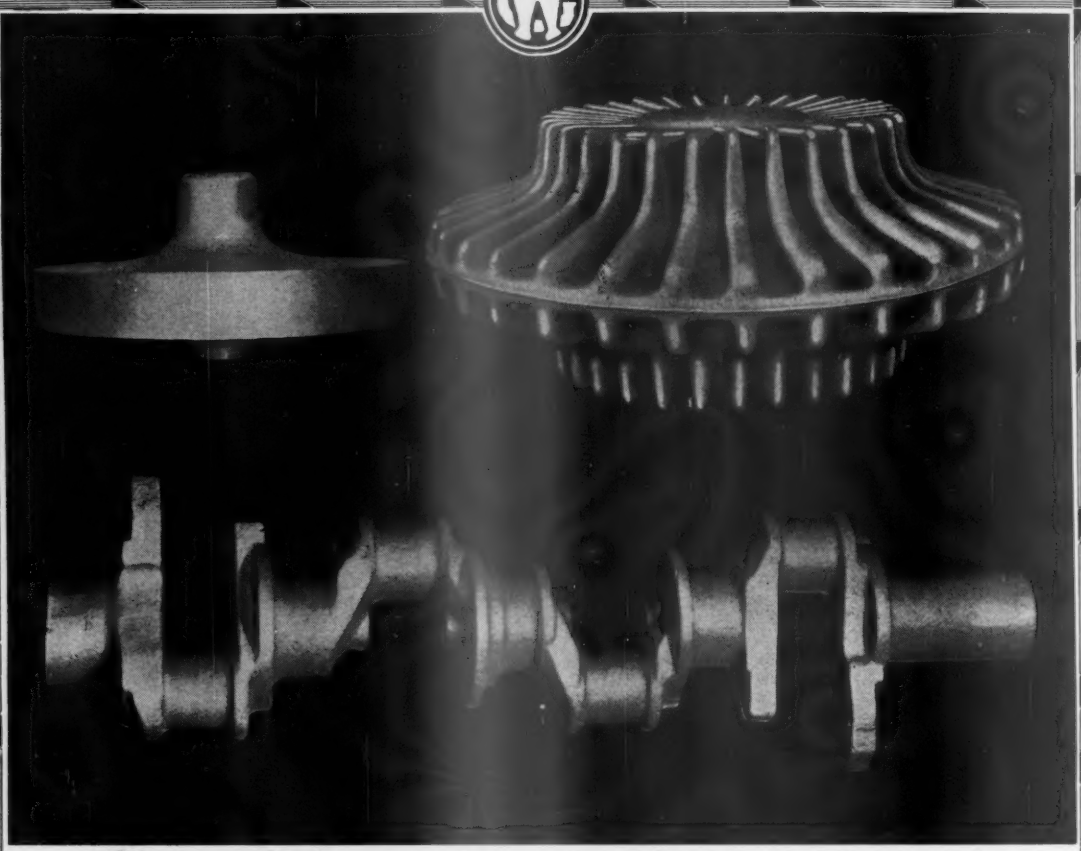
One of the secrets of the new Boeing Stratocruiser's amazing 4,200-mile range is 35 bantamweight Goodyear Pliocel fuel tanks of 7,700 gallon capacity, stowed inside the giant wing. Pliocels, a development of Goodyear Research, are made of specially treated, gas-tight nylon fabric. They weigh only .080 lb. sq. ft. providing maximum gas capacity with minimum weight. They outlast heavier metal tanks—can be built to fit any size or space, permitting fuel stowage in places heretofore impractical or impossible. For the full story on Pliocels or other Goodyear Aviation Products, write: Goodyear Aviation Products Division, Akron 16, Ohio and Los Angeles 54, California.

Pliocel—T.M. The Goodyear Tire & Rubber Company

GOODYEAR
AVIATION
PRODUCTS

This large Pliocel tank is easily folded for installation through small apertures, as shown in top photograph.

MORE AIRCRAFT LAND ON GOODYEAR TIRES, TUBES, WHEELS AND BRAKES THAN ON ANY OTHER KIND



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Cover—Rocket-assisted take-off aids Navy's giant Constitution.

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I.A.S. News

A Record of People and Events of Interest to Institute Members

'Human Engineering' Session Planned for Annual Meeting

Psychological and Physiological Factors in Aviation to Be Discussed in Full Session; Air Transport Day to Feature General Kuter of M.A.T.S. as Guest Luncheon Speaker; Joint Sessions with American Helicopter, Physical, Meteorological Societies and Institute of Navigation Planned; Reichelderfer of Weather Bureau, De Florez to Speak

AVIATION PSYCHOLOGY AND PHYSIOLOGY are to receive special attention at the Seventeenth Annual Meeting of the Institute of the Aeronautical Sciences, again to be held in the Hotel Astor, New York City, January 24–27, 1949, plans for the event reveal. The program is being set up with the cooperation of the National Research Council and the Council's Chairman of the Committee on Aviation Psychology, Morris S. Viteles, who also is Chairman, Department of Psychology, University of Pennsylvania.

▸ **Recognizes Need**—The Institute's move including a session on human engineering in the field of aviation in the program is in recognition of the great need for making known to engineers and other scientists what is being done by aviation psychologists and physiologists, since the human factor plays so important a part in the effective use of the aeronautical equipment being designed.

N.R.C.'s Committee on Aviation Psychology has been carrying on research in that field for many years. Four or five papers on the following types of subjects are tentatively planned:

- Human aspects of airplane instruments.
- Psychological factors in the recognition and avoidance of the inadvertent stall.
- Objective qualifying examinations for the airline transport rating certificate.
- Physical factors in safe flying.
- The Contribution of Psychology to Efficiency and Safety in Flight.

Joint sessions with other societies are also planned. The meeting with the American Helicopter Society will feature two papers on jet-propelled helicopters: one on the Marquardt Whirlajet and the other on the McDonnell jet 'copter.

There will be two sessions on Aerodynamics—one with the American Physical Society on fluid dynamics, and the second devoted to transonic and supersonic problems.

A discussion of the intermediate C.A.A. program on flight traffic control and a paper on the ultimate traffic control system 15 years in the future will be given in the joint meeting with the Institute of Navigation.

The session on meteorology with the American Meteorological Society will include papers on upper atmosphere research and cloud precipitation.

The Honors Night Dinner will, as last year, be held on the evening of the opening day of technical sessions.

President John K. Northrop will preside at the Dinner as toastmaster. He will name the newly elected Honorary Fellows and Fellows for 1949, as well as announce winners of the Reed, Losey, and Sperry awards.

Three luncheon guest speakers have been selected for the succeeding days—F. W. Reichelderfer, Director, U.S. Weather Bureau; Rear Adm. Luis de Florez, U.S.N. (Ret.); and Major Gen. L. S. Kuter, Commanding General, Military Air Transport Service.

Luncheon Speakers Scheduled for Annual Meeting: *The Seventeenth Annual Meeting of the Institute of the Aeronautical Sciences will have as its guest Luncheon speakers (left to right) F. W. Reichelderfer, Director of the U.S. Weather Bureau, Luis de Florez, President, de Florez Engineering Company, and Major Gen. L. S. Kuter, commanding M.A.T.S.*

Cornell Air Safety Program Described by Dr. C. C. Furnas

THREE PHASES OF THE Cornell Aircraft Safety Program were outlined by Dr. Clifford C. Furnas, I.A.S. Associate Fellow and Director of Cornell Aeronautical Laboratory, at an Air Safety Meeting in New York. The research phases include the "head impact" project, fire prevention in the air and following crashes, and air navigation and traffic control.

▶ **Crash Data Collected** — Overall purpose of the Head Impact Investigation Project is to obtain data on physical characteristics of aircraft cockpit structures and equipment which will aid in reduction of fatalities due to injuries to the head. From data collected during the investigation of 600 private airplane crashes, it has been established that over 75 per cent of the fatalities come from injuries to the head.

This high percentage is due to conventional use of seat belts without shoulder harness, which results in a forward motion of the upper portions of the body and head during the rapid deceleration of the plane in a crash landing. The head then strikes such equipment as instrument panels, flight instruments, and control columns and also aircraft structural components such as door posts and window frames.

▶ **Catapulted 'Heads'**—The Cornell Aeronautical Laboratory in approaching the problem developed a plastic headlike form from medical data which indicates that a fracture of the skull may result in a free fall drop of about 5 ft. onto a hard, nonresilient surface. The head form consists of a plastic shell shaped to the approximate principal dimensions of the human head and filled with a gelatinous mass to a weight of about $9^1/_2$ lbs.

These head forms are placed on a catapult apparatus and accelerated into various types of panels and similar structures.

Test results indicate that panels that collapse under the impact without providing an elastic rebound offer the highest degree of protection to the head form. It has been shown that if the heads are catapulted at a velocity of 45 to 50 ft. per sec. against a panel made up of thin aluminum sheet, backed up by a spongelike plastic foam, they will survive the blow without fracture or apparent injury, even though the average force exerted on the head during the stopping period was more than 150 times its own weight.

It is planned to extend the investigation up to striking velocities as great as 150 ft. per sec., with the objective of setting up design criteria that will point the way to building planes in which the occupant will have a reasonable chance of survival even in crashes up to 100 m.p.h.

▶ **Fire Prevention Research**—One of the sources of fire in the air has been the ignition of fuel vapors in the tanks or surrounding spaces, Dr. Furnas said. The Laboratory has a contract with Navy Bureau of Aeronautics to develop an inerting system whereby the vapor space in the fuel tanks and wing space surrounding the tank area will be rendered inert against a combustible mixture at all times during flight or on the ground.

The system, which has been tried out for 2 years on a Convair PB4Y-2, consists of taking a small portion of the exhaust gas from the engine, which is practically free of oxygen; cooling; then condensing out the moisture and corrosive constituents; and inducting these cool, dry, inert gases to the fuel tanks and surrounding wing space. In this way the tanks at all times are vented to inert gases that will not support combustion, rather than being in contact with air.

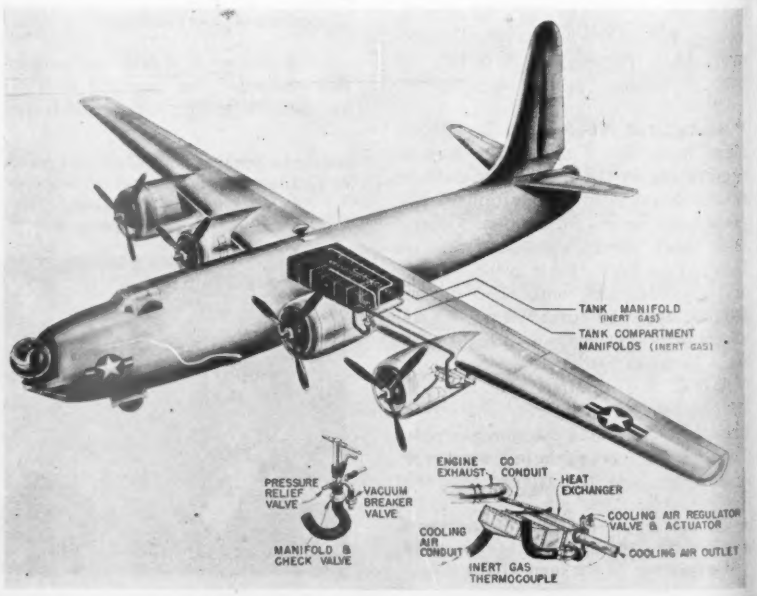
▶ **System Well-Proven**—Gas analyses on extensive flight tests have shown that the vapor spaces with this system in operation have an oxygen content that is always below the combustible limits, Dr. Furnas declared. The system is fully automatic, is light in weight, requires practically no maintenance, and is sufficiently well-proved to justify its use in commercial or military aircraft, he added.

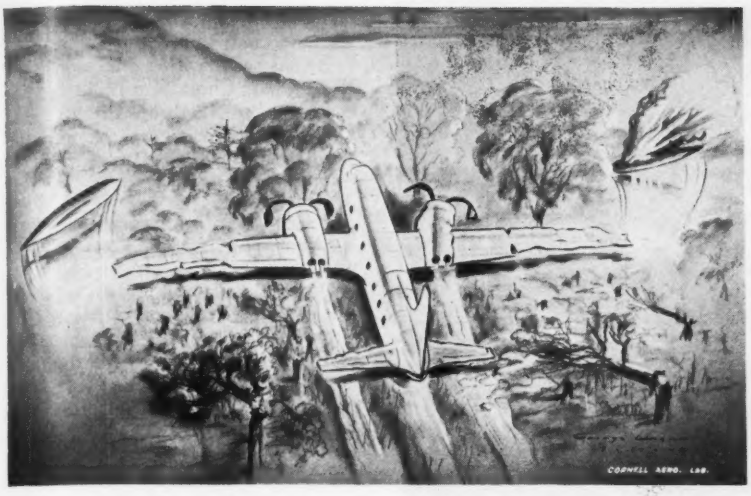
Another phase of fire hazard research is the alleviation of hazards in the event of crashes.

▶ **Remove Internal Tanks**—A careful study has been made, Dr. Furnas said, of using external wing-tip fuel tanks on a transport plane. The study has indicated that this would be entirely feasible and practical for moderate-range aircraft. There would be little or no increase in drag of the airplane in flight and little or no increase in the structural weight required. Such tip tanks would have these obvious effects:

- All fuel can be jettisoned if a crash is imminent.

Inerting System Eliminates Fuel Tank Fire Hazards: *Cornell Aeronautical Laboratory, under contract with the Navy, has developed a proven inerting system whereby vapor space in fuel tanks and space surrounding tanks is rendered inert against a combustible mixture at all times during flight. System is that of venting fuel tanks by means of piping to engine exhaust stack which emits inert gas. In the piping is heat exchanger to reduce exhaust gas temperature. Heat exchanger also serves as condenser to remove corrosive elements so that cool, dry exhaust gas is directed into fuel tanks. No detrimental effects on engine performance result, Cornell says. Branch line of piping is also directed into spaces surrounding tanks, rendering them inert at same time. System is fully automatic, light in weight, requires practically no maintenance.*





'New Look' in Crash Landings: *By carrying fuel tanks at wing tips only, medium-range transports will have less fire hazard to face in the event of a crash landing than do aircraft provided with internal wing tanks. According to Cornell Aeronautical Laboratory, tip fuel tanks provide little or no increase in drag or in structural weight required.*

• Impact separation of the tanks can be incorporated for those circumstances where there is no forewarning of a crash, and the tanks will follow their own course—away from the plane.

• Because of the remoteness of the fuel (at wing tips only) from the passengers, the fire hazard would be reduced to a minimum under any event.

▸ **Traffic Control**—The third vital phase of the Aircraft Safety Program concerns the problem of navigation and traffic control.

The Laboratory has completed a thorough analytical and mathematical study of the problems involved in organizing and controlling traffic of a large number of planes, flying on instrument, distributed at random through the air space in the vicinity of an airport.

This is a problem of extreme complexity, Dr. Furnas concluded, which must be solved in general form before completely reliable traffic control systems can be devised for handling high-density air traffic in periods of low visibility.

It is expected, he said, that this study may lead to experimental work on improved instrumentation and communication systems.

Piasecki's Dream Capsule Featured in New XH-16 'Copter

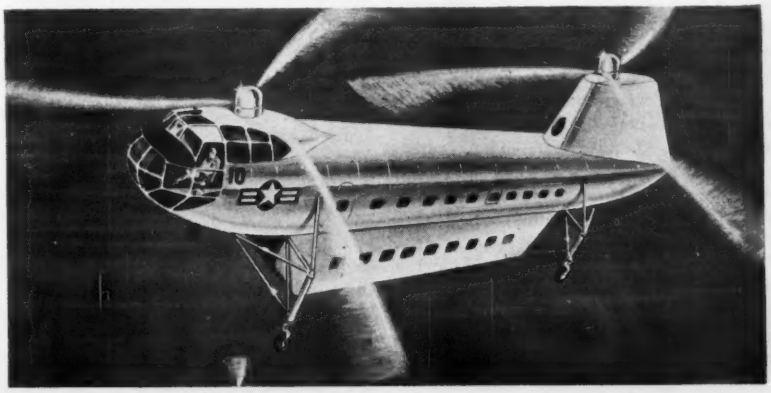
In announcing the development of the largest helicopter ever to be built, the U.S. Air Force made the first public step toward realizing Frank N. Piasecki's dream back in 1942 of a quickly detachable capsule that about doubles the pay load of his latest helicopter design, the XH-16.

▸ **DC-4 Size**—The XH-16, an "enlargement" of the XHJP-1 developed and built for the Navy, compares in general shape and dimensions to the fuselage of a Douglas DC-4 and follows the tandem-rotor configuration pioneered by Piasecki, an I.A.S. Technical Member.

The capsule to be used with the XH-16 is about the size of a Greyhound bus and is quickly detachable. The huge transport 'copter will be capable of carrying the biggest load the greatest distance ever achieved by a rotary-wing aircraft. The combination of long-range planes carrying capsules to a pickup point where the Piasecki XH-16 would provide "local" delivery service presents a flexibility never before possible in supply and evacuation.

It is expected that two prototypes of the new helicopter will be available to the Air Force within the next 2 years. Similar to the XHJP-1 prototype in general appearance, the XH-16 is an all-metal, aerodynamically clean design. While the number of combat troops which can be carried in it cannot be revealed, it is obvious that in combination with an air-liner's cabin space and the all-metal bus-sized capsule, the new transport helicopter will be able to accommodate great numbers of men and their equipment and supplies.

Piasecki 'Truck-and-Trailer' of the Air: *Drawing of the Piasecki XH-16 tandem-rotored transport helicopter showing the quickly detachable capsule, comparable with a Greyhound bus in size, attached to the huge fuselage, which is as big as a DC-4. Piasecki first presented his version of the detachable capsule to the Army Air Forces back in 1942 in the form of a conventional cargo transport design featuring the quick loading and unloading capsule scheme.*



N.A.C.A. Cleveland Laboratory Named in Tribute to Lewis

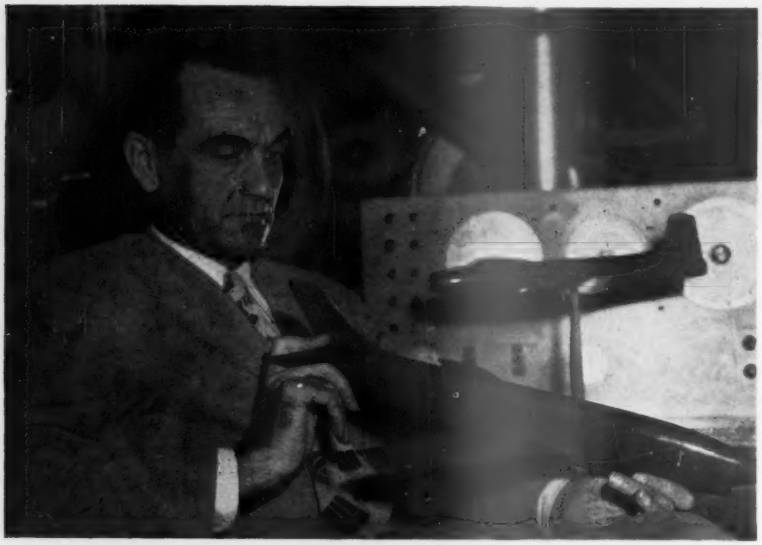
The great flight propulsion laboratory at Cleveland has been named in honor of the late Dr. George W. Lewis by the National Advisory Committee for Aeronautics in a ceremony September 28.

The commemorative service, in which Dr. Jerome C. Hunsaker formally named the laboratory, was the first event in the 3-day showing of the research center held annually for leading civil and military aviation specialists.

The Lewis Flight Propulsion Laboratory, probably the greatest research center of its kind in the world, is a $37,000,000 establishment employing 2,500 persons. Every kind of propulsion for aircraft and missiles is covered in its work.

▸ **Supersonic Compressor**—Officials revealed at the ceremony the development of a supersonic compressor for gas turbines in which a single row of blades accomplishes the work of five rows used previously.

At the same time, a ram-jet test missile was shown which was clocked at 1,600 m.p.h. in drop tests. These tests have been made at Wallops Island near Chincotague Island, Va., the officials said.



STACK RECEIVES FIELD OF SCIENCE AWARD

John Stack, Assistant Chief of Research at National Advisory Committee for Aeronautics, Langley Laboratory, and I.A.S. Fellow, received the Air Force Association's Field of Science Award at A.F.A.'s last convention in New York. Citation was for "his pioneering research to determine the physical laws affecting supersonic flight, and for his conception and aggressive prosecution of a sound program for the construction of research aircraft, leading to the successful achievement of airplane flight through the speed of sound." Award is one of four new aviation awards to be given annually by A.F.A.

Details of the world's largest supersonic wind tunnel also were given with speeds up to approximately 1,300 m.p.h. being credited to the new installation, which will soon be in operation.

Franklin Gold Medal Awarded von Kármán

The Franklin Medal for 1948 has been awarded to Dr. Theodore von Kármán, Chairman of the Scientific Advisory Board of the U.S. Air Force and Honorary Fellow of the I.A.S., by the Franklin Institute's Committee on Science and the Arts. Richard T. Nalle, President of the Franklin Institute of Pennsylvania, made the presentation to Dr. von Kármán at traditional Medal Day ceremonies held in Philadelphia, October 20.

▶ **'Unusual Leadership'**—The gold medal, which carries a medallion of Benjamin Franklin, is awarded annually to workers, regardless of their country or creed, who have done most to advance a knowledge of physical science and its applications.

In presenting the high honor to Dr. von Kármán, President Nalle said it was given "in recognition of his outstanding engineering and mathematical achievements, particularly those relating to the development of advanced aerodynamic conceptions which have directly influenced the progress of aeronautical design; and for his unusual leadership whereby some measure of his own genius is constantly instilled in those who work with him."

▶ **Distinguished Career**—Dr. von Kármán, who was born in Budapest, Hungary, in 1881, came to this country first in 1926 and for permanent residence in 1930. Since then he has been Professor of Aeronautics and Director of the Guggenheim Aeronautical Laboratory at Cal-Tech.

Before coming to this country, he had a distinguished career in engineering; he was graduated as a Mechanical Engineer from the Royal Technical University in Budapest and received his Ph.D. degree from the University of Goettingen, Germany, as well as several honorary degrees from universities in Europe and the United States.

He is a member of the Royal Society of London, the French Academy of Sciences, and is an Honorary Fellow of the Royal Aeronautical Society.

▶ **Known for Vortex Theories**—Best known for his theories of vortex motion and turbulence in fluids and for his work in supersonic aerodynamics, Dr. von Kármán has made many contributions to the theory of elasticity, the knowledge of strength of materials, hydrodynamics, aerodynamics, and thermodynamics.

He has been visiting professor in the U.S., Japan, China, and India and is a consultant to Northrop Aircraft, Inc., General Electric Company, and the Aerojet Engineering Corporation.

Compton Succeeds Bush As Top Research Executive

Dr. Karl T. Compton, I.A.S. Fellow and eminent President of Massachusetts Institute of Technology, has been selected by President Truman to succeed Dr. Vannevar Bush as Chairman of the Research and Development Board of the national military establishment.

▶ **Top Scientific Post**—Thus, in a crucial period of national existence, Dr. Compton becomes the chief man in American science, taking over a post that will be a pre-eminent factor in preventing, or preparing for, World War III.

He is, as Chairman of the seven-man Board, the only civilian among six high ranking officers, two each from the Air Force, Army, and Navy. He reports directly to the Secretary of Defense, handling top secret matters on turbojects; atomic energy; guided missiles; strategic materials, including uranium; and new electronic devices.

Dr. Compton, who has been President of M.I.T. since 1930, was Chairmen of the President's Advisory Commission on Universal Training. During the war he worked closely with Government and military departments as an official of the Office of Scientific Research and Development and has been Chairman of the Joint Chiefs of Staff evaluation board on atomic bomb tests since 1946.

He took office as Chairman of the Research and Development Board on October 15.

Enyart First American Head of Fedération Aéronautique

William R. Enyart, Associate Fellow of the Institute and President of Simmonds Aerocessories, Inc., has been elected the first American President of the Fédération Aéronautique Internationale, world governing body of sporting and private aviation.

▶ **Succeeds Britisher**—Mr. Enyart, who is a board member and one-time President of the National Aeronautic Association and Chairman of the I.A.S. New York Section, succeeds Lord Brabazon of Tara as head of the 43-year-old organization.

Although Mr. Enyart will be the first American to serve as President of F.A.I., Godfrey L. Cabot, of Bos-

ton, a pioneer United States aviation leader and N.A.A. life member, was honored by F.A.I. some years ago with the designated title of Honorary President.

The 1948 conference in Paris, at which Mr. Enyart was elected, was attended by 64 delegates from 26 nations. The conference voted, with only three dissenting votes (Russia, Poland and Rumania) to accept the invitation of the U.S., through its official representative, the N.A.A., to hold the 1949 annual conference in Cleveland, Ohio, beginning August 29, just preceding the National Air Races.

Convair's Plane Lease Plan Revamps Manufacturer-Air-Line Relationship

Announcement of the formation of the Convair Equipment Corporation by Consolidated Vultee Aircraft Corporation as a subsidiary to lease Convair-Liners to air lines may open up an entirely new phase in the relationship of plane manufacturers and air lines.

Originally conceived as a Convair-Liner leasing proposal, the plan could cover a far greater territory than one manufacturer. Depending on a favorable reception, the new corporation will buy planes from other manufacturers for lease to air lines. In the meantime, it is to purchase 100 Convair-Liners, which will be leased with an option to buy.

▸ **Possible Developments**—A leading figure in the plan acted upon by Floyd P. Odlum, Convair Chairman of the Board, is William C. Rockefeller, Odlum's Executive Assistant and an I.A.S. Associate Fellow. According to present plans, the new corporation is to be capitalized at $50,000,000 representing working capital.

Should reception of the plan prove favorable, possible developments of the Convair Equipment Corporation include undertaking major overhauls on leased planes and maintaining spare parts inventory and financing sales of new transport aircraft, in addition to buying new planes from other manufacturers for lease to interested air lines.

Delos W. Rentzel Announces C.A.A. Reorganization

Both the Washington and Regional structure of the Civil Aeronautics Administration are being reorganized along functional lines, Administrator Delos W. Rentzel, I.A.S. Honorary Member, announced.

▸ **Like Activities Grouped**—"The streamlining through the grouping of like activities so as to achieve maximum unity of direction and fixed responsibility is part of the continuing process of keeping pace with changes in the aviation industry," he explained.

Following regional reorganization, each phase of the aviation industry will need to deal with only one specialist in its problems and operations instead of with several, thus avoiding duplication and overlapping.

▸ **Deputies Reduced**—The number of Deputies has been reduced from three to one. This Deputy has been granted full "across-the-board" authority to deal effectively and decisively with all operating problems that might arise.

In addition, the office of Field Operations is abolished, and groups such as the Office of Aviation Information, Office of Aviation Education, and Assistant to the Administrator for Personal Flying, have been merged into the Office of Aviation Development. The Administrator has also created a new office, Program Planning and Evaluation, to meet the need for a relatively small but highly specialized group primarily charged with top-level planning and evaluation of major C.A.A. programs, domestic and international, Mr. Rentzel said.

National Meetings Calendar

December 17	Wright Brothers Lecture, Washington, D.C.
January 24–27	Seventeenth Annual Meeting, New York

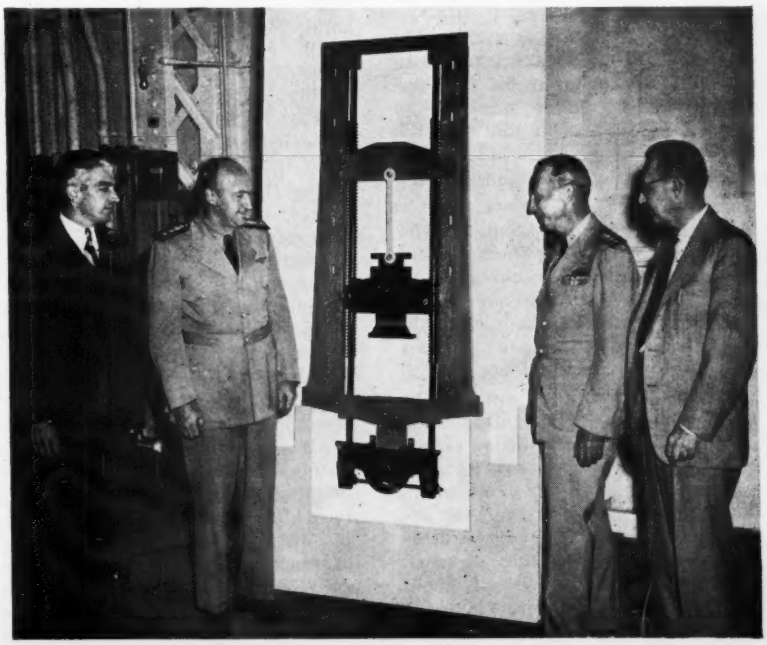
For details see page 100.

15-Year Program for All-Weather Flight System Under Way, F. B. Lee Says

In a paper delivered before the S.A.E.'s National Aeronautic Meeting in Los Angeles, Frederick B. Lee, I.A.S. Member and Deputy Adminis-

WORLD'S BIGGEST UNIVERSAL TESTING MACHINE DEDICATED

Dedication of the world's largest universal testing machine (model of which is shown) took place at the U.S. Naval Air Experimental Station's Aeronautical Structures Laboratory at the Philadelphia Naval Base with Rear Adm. F. W. Pennoyer, Commander, Naval Air Material Center, an I.A.S. Fellow, giving one of the principal addresses. Grouped about the model with Admiral Pennoyer are: A. H. Emery, President, A. H. Emery Company; Rear Adm. A. M. Pride, Chief, BuAer; Admiral Pennoyer; and W. W. Smith, Executive Vice-President, Baldwin Locomotive Works, builders of the 5,000,000-lb. machine. Navy acceptance tests showed accuracy within 1/4 per cent on all six ranges down to 0–24,000 lbs. or 0.005 of full capacity. Load variations of only 5 lbs. can be measured on the machine. Paradoxically, this 5,000,000-lb. capacity machine will be used for testing the lightest weight aluminum and magnesium structures that aeronautical engineers can design to meet the severe requirements of modern flight.



JET INVENTOR INSPECTS BOEING'S LIGHTWEIGHT GAS TURBINE

Features of the 85-lb., 150-lb. thrust gas turbine built by Boeing Airplane Company are explained to Sir Frank Whittle, inventor of the jet propulsion engine by Dan Hage, Chief of Boeing's Engineering Division Propulsion Unit. Sir Frank, British Overseas Airways Corporation adviser, made one of the principal speeches at the Northwest Aviation Planning Council convention in Vancouver, B.C.

trator of Civil Aeronautics, said a program for an all-weather flight system for combined military and civilian use has been agreed upon in detail through the Radio Technical Commision for Aeronautics.

The very existence of the U.S. may depend upon the rapid development of an all-weather flying system for military and commercial planes, he said.

▸ **Cost Over $1,000,000,000**—Most economical estimates reveal that the program will cost more than $1,100,000,000 to implement and will require 15 years—until 1963—to be placed in complete operation, Mr. Lee said.

The cost, he pointed out, will be spread over a 15-year period and will be far overshadowed by direct financial benefits to the taxpayer. Direct air-line losses from schedule unreliability, for example, are at least $40,000,000 a year, he added.

"By making full use of our airports, all-weather flying will, for all practical purposes, add almost a billion dollars to our airport values without an additional cent of airport expediture." The United States already has approximately $6,000,000,000 invested in civil airports, and these, because of bad weather, are closed about 15 per cent of the time, Mr. Lee said.

North America Companies Join Institute

The Insurance Company of North America and its affiliated companies—The Alliance Insurance Company of Philadelphia, Philadelphia Fire and Marine Insurance Company, and Indemnity Insurance Company of North America—is the latest Corporate Member of the I.A.S.

▸ **All Forms of Insurance**—The North America companies are underwriting all forms of aviation insurance. This service was recently added for the convenience of agents, brokers, and insureds, augmenting extensive "across-the-board" facilities for underwriting all forms of fire, marine and casualty insurance through a single group.

Through the North America companies' Aviation Department, all forms of protection are provided for the privately owned, the corporate-owned, or commercially owned and operated aircraft. The Indemnity Insurance Company of North America is also extensively engaged in the writing of aviation accident insurance for pilots and passengers through its Accident Department. These facilities are wide in scope and include insurance covering all the diversified activities of the industry from gliders to experimental prototypes in the transport category of both fixed and rotary-wing aircraft, powered by reciprocal, turbojet, or turboprop engines.

Special accident prevention engineering surveys are made for most insureds.

▸ **Founded in 1792**—Insurance Company of North America was founded in 1792 and has been one of the leading factors in American insurance for more than 150 years. On January 1, 1946, the Insurance Company of North America companies broadened their facilities to include aviation and have since been providing protection to a large segment of the industry.

Air Line Meals Still on House

According to Merrill F. Redfern, I.A.S. Associate Member and V.-P. Traffic and Secretary of Air Transport Association, air lines (1) have not discontinued serving meals, (2) do not charge for meals, and (3) do not contemplate doing either.

Convair Flying Auto to Be Continued by Designer

The flying auto discontinued by Consolidated Vultee Aircraft Corporation will be continued in its development by its designer, T. P. Hall, Associate Fellow, at Gillespie Field, San Diego.

▸ **Nearly Ready for Production**—Hall was Chief of Engineering, Flying Automobiles, for Convair, to whom all rights, including the craft itself, reverted when Convair stopped expenditures on the development, said some flight testing and minor engineering modifications remain to be completed before it will be ready for production.

More than $800,000 has been spent on the current model, and only a comparatively small amount will be necessary to get the roadable plane ready for production, he added. Several propositions are being considered by the designer.

A four-place vehicle with a detachable flight section powered by a separate 190-hp. Lycoming engine, in addition to a 26.5-hp. Crosley engine mounted in the rear of the automobile, cruising speed is more than 100 m.p.h. Top ground speed is 67 m.p.h.

Car body is of plastic and acts as landing gear for the plane.

Three I.A.S. Members Awarded Certificate of Merit

Among 29 scientists and engineers of the New York metropolitan area who received the President's Certificate of Merit for outstanding services to the Armed Forces while members of

the Office of Scientific Research and Development during the last war were Ward F. Davidson, I.A.S. Associate Fellow; and Eugene F. Du Bois, I.A.S. Member, Professor of Physiology, Cornell Medical College.

Presentation of the awards was made by Major Gen. Julius Ochs Adler, U.S.A. (ret.) in New York.

Gifts to the Institute Collections

John P. V. Heinmuller gave an album of 44 autographed air-mail covers, each bearing the signature of one or more pilots or officials connected with the various flights, including signatures of Wilbur Wright, Orville Wright, Glenn H. Curtiss, Earle Ovington, Woodrow Wilson, Theodore Roosevelt, Peary, Amundsen, Byrd, and others. Two of the cards in this album were flown at the Boston-Harvard Aero Meet of September, 1910, and are signed by Claude Grahame-White and Thomas S. Baldwin. Mr. Heinmuller also gave 97 Zeppelin air-mail covers; 87 pioneer and historical air-mail covers of various countries; 106 flown Lindbergh letters and clippings and photographs of Lindbergh flights; and 7 albums of clippings, photographs, logbook sheets, and other data on airship flights, principally the "Graf Zeppelin" and the "Hindenburg."

Charles H. Colvin gave books, pamphlets, and sheet music, including Stark's *Blind or Instrument Flying*, Newark, 1931. Clarence D. Hanscom sent a set of pictures illustrating the structure of the Vought Model XO4U-1 airplane. Files of several aeronautical periodicals were received from George T. Rutledge. The Radio Corporation of America sent 784 periodicals through the courtesy of Miss Fern Cloak.

Logbooks, scrapbooks, articles, and clippings relating to the flying activities of Eddie A. Schneider, who established a junior transcontinental flying record, were received from Mrs. Gretchen Schneider Gray. Reports and translations were received from the Cornell Aeronautical Laboratory through the courtesy of Miss Elma T. Evans. Books and reports were received from the Republic Aviation Corporation through the courtesy of Mrs. George Burrell.

Corporate Member News

• Expanding Jet Activities . . . **Aerojet Engineering Corporation's** newly acquired Marquardt Aircraft Company, designers of first ram-jet helicopter, is expanding its ram-jet activities by taking over former Timm Aircraft property at Van Nuys, Calif.

• Speed Temperature Graph in Color . . . **AiResearch Manufacturing Company,** Los Angeles, has printed a speed temperature graph in color showing temperature created by ram compression on aircraft skin surfaces at extreme high speeds . . . More than $2,000,000 worth of orders for specialized equipment on military planes, including advance-type refrigeration units and cabin pressure controls, have been received by company recently.

• DC-6 Load Factor Up . . . **American Airlines** reports that with no extra fare for the DC-6, load factor has gone from below to above the system average. About 10 per cent of reservations are made under the family plan.

• Bonanza Air Conditioning . . . Working on the water evaporation principle, an experimental air-conditioning plant is being tested for the Bonanza by **Beech Aircraft Corporation.** Unit fits into cabin roof of Bonanza and is in early development stage. Future use in production models has not yet been decided by Beech.

• In the Valve Business . . . **Bell Aircraft Corporation** has bought the capital stock of W. J. Schoenberger Company, Cleveland, which produces valves and fittings for the gas appliance and air-conditioning industries. Company will operate as a subsidiary without change in personnel. Move is in line with Bell's development of products for commercial markets outside aircraft field, Bell said . . . Flight testing of the XH-15, two-bladed rotor helicopter has been announced. Three of the 100-m.p.h., 2700-lb. models have been ordered by Air Force.

• Flight Refueling for B-50's . . . While work has been on the assembly-line basis at **Boeing Airplane Company's** Wichita factory converting B-29 bombers so that they may be refueled in flight, similar work has begun on the newer B-50 Superfortresses. Refueling-in-flight technique, perfected by British, is in line with U.S. Air Force program of establishing first true global striking force . . . Wichita plant also has laid tooling and production plans for producing the B-47 Stratojet. Payroll is expected to increase from 5,000 to more than 15,000 as a result . . . The 70-ton Stratocruiser has been dive-tested at speed of 498 m.p.h.—faster than any transport airplane its size has flown. Normal cruising speed is from 300–350 m.p.h.

• Small Jet Plane and Engine Developed . . . **Cal-Aero Technical Institute,** Grand Central Airport, Glendale, Calif., has developed a design for a single-place jet plane and compact engine of 240-lb. thrust. Plane, with 20-ft. 10-in. span and overall length of 17 ft. 1 in., will be of all-metal construction. Overall height is 5 ft. 11 in. Air intakes are alongside fuselage, with exhaust at bottom of fuselage. Bicycle-type landing gear with small outrigger wheels at wing tips are used. Cal-Aero says plane will be capable of 250 m.p.h., with range of 325 miles. Fuel consumption is estimated at 75 gal. per hour; rate of climb

Silicone News

DC SILICONES

More Power Per Pound†

Call it plain laziness or call it "divine discontent", some potent force has driven us to seek more concentrated motive power ever since man started to move on wheels. But each increase in horsepower per pound has increased operating temperatures and created a need for more heat resistant materials. Dow Corning Silicones help to supply that need in such major developments as the new air-cooled gasoline engine by Continental Motors Corporation of Detroit.

(PHOTO COURTESY CONTINENTAL MOTORS CORPORATION)

Horsepower per pound in Continental's new line of air-cooled gasoline engines is increased as much as 100% in engines below 250 hp . . . more than 300% (down from 2400 to 777 lbs.) in the horizontally opposed 8 cylinder 250 hp engine shown above. In this type of engine, Silastic gaskets are essential parts of the standard push-rod and tube assembly.*

Among the many problems solved by Continental engineers in designing this compact power plant, was the leakage of oil around the push-rod tube assembly. Hot oil and operating temperatures up to 500° F. severely limited the life of conventional gasketing materials. Continental engineers, however, knew about Silastic, the rubber-like Silicone by Dow Corning, and they asked for samples and technical assistance.

Silastic solved this problem because it is more heat-stable and more resistant to hot oils and to permanent deformation at temperatures above 200° F. than any other resilient material. Use of engines in sub-zero weather is not restricted by these gaskets of Silastic 161 because they are serviceable from —90° to 500° F. For more information about Silastic, ask for data sheet No. F-5S.

†See Silicone News, Dec. 1947, for story on 50% reduction in size and weight of electric motors made possible by Dow Corning Silicone Insulation.

*TRADE MARK REGISTERED U. S. PAT. OFF.

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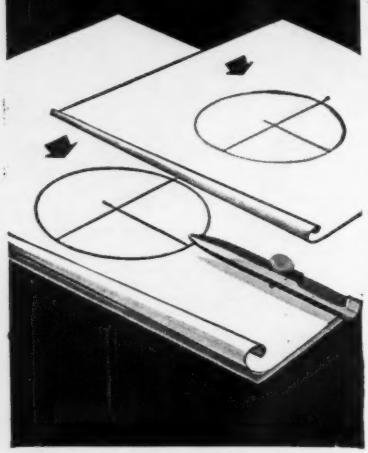

• The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

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at 1,380 ft. per min., and service ceiling at 35,000 ft. Cal-Aero is trying to interest Air Force in the design as a target drone.

• Tailless Jet Fighter Tested . . . Navy jet fighter, XF7U-1, a tailless-type produced by **Chance Vought Aircraft Division,** United Aircraft Corporation, received its initial test flights at Patuxent Naval Air Test Center. Powered by two Westinghouse 24C turbines located at wing roots, XF7U-1 has the elevon control system developed by Northrop for Flying Wing design but also uses rudder controls on two vertical fins on wings for increased stability. Leading-edge flaps are used to get high lift characteristics from sweptback wings at low speeds. Armament is in the nose.

• B-50 Nose Sections Subcontracted . . . **Consolidated Vultee Aircraft Corporation** will deliver first B-50 nose sections next spring under its subcontract to Boeing. Total of 167 sections will be built at cost of $5,000,000–$6,000,000 . . . Convair has been authorized to begin production of B-49 Flying Wing jet bomber designed by Northrop. Meanwhile, Convair-Liner production is 28 transports per month.

• Profitable Nine Months . . . **Continental Motors Corporation** reports profit of $2,536,129 after taxes on sales of $85,592,860 for 9 months ending July 31.

• Navy has ordered 800 Mark XII droppable fuel tanks, with deliveries starting this month, from **Curtiss-Wright Corporation's** Columbus plant, bringing total orders for this item to 5,800 . . . BuAer awarded Curtiss-Wright a $2,000,000 contract for overhaul of 49 R4D (C-47) transports. Job is expected to be completed by July 1, 1949.

• To Produce Flight Simulators . . . **Propeller Division,** Curtiss-Wright Corporation, at Caldwell, N.J., is being expanded to produce electronic flight simulators designed by Dr. R. C. Dehmel of the Curtiss-Wright Electronic Trainer Department. A concrete and steel structure with glass sidewalls is scheduled for completion in March, providing total floor area of the Division of 800,000 sq.ft.

• New Fire-Resistant Hydraulic Fluid . . . **Douglas Aircraft Company, Inc.,** together with Monsanto Chemical Company, recently disclosed the development of a new fire-resistant hydraulic fluid called "Skydrol." New fluid is a synthetic liquid combining most of the desirable characteristics of existing hydraulic fluids with fire-resistant qualities never before attained. Skydrol has viscosity index of 160 and operates satisfactorily at temperatures down to 40° below 0. Operated in an aircraft hydraulic system test stand for the equivalent of more than 4,000 flight hours under maximum pressure at a temperature of 160°F., viscosity loss due to shear breakdown was less than 18 per cent. Presently used fluids undergo 30 per cent breakdown in about 2,000 hours' operation, Douglas said. Monsanto will produce and market the new fluid.

• Plan Recreation Center in Miami . . . A $250,000 recreation center for **Eastern Air Lines'** 4,000 employees in Miami will occupy an area approximately two blocks square across the street from Eastern's operations and maintenance base on Northwest 36th St., Capt. Eddie Rickenbacker announced.

• Jet Engine Container . . . **Edo Corporation** has developed a shipping container for jet engines with built-in shock absorbers capable of reducing a 47*g* exterior load to an impact of only 8g's on the engine itself. Container is constructed almost entirely of aluminum and consists of three basic parts: engine stand, moisture barrier, and elastic cage. Weighing about 1,000 lbs., less than previously used wooden crates, container was made under contract to Navy BuAer.

• 30 Panthers a Month Scheduled . . . **Grumann Aircraft Engineering Corporation,** which began production of the F9F Panther last month, will have 30 of the jet fighters rolling off the assembly line every month by July.

• New West Coast Office . . . A branch office in Los Angeles has been opened by **Jack & Heintz Precision Industries, Inc.,** at 409 Hollywood Professional Building, 7046 Hollywood Blvd., Hollywood 28, Calif. Direct teletype service is maintained with factory headquarters to facilitate communications.

• F-80 with Ram-Jet . . . **Lockheed Aircraft Corporation** has been testing an F-80 equipped with ram-jet engines fitted in the wing tips for auxiliary power. Developed by Marquardt Aircraft, the ram-jets in the F-80 have been used in experiments for several months at the Van Nuys Airport, the F-80 attaining speeds in the high subsonic regions without structural failure. Project was undertaken under contract with Air Materiel Command . . . Lockheed is considering development of new L-849 Connie powered by Wright Turbo-Cyclone 18 compound engines. Capable of 20 per cent power increase, engines would permit take-off weight of 110,000 lbs., an increase of 8,000 lbs. over maximum allowable in L749 series.

• Berlin Airlift Ups Payroll . . . **Lockheed Aircraft Service** has hired 300 additional workers to fulfill contract to recondition C-54's used on the Berlin airlift. Total number of workers at the MacArthur Field base is expected to be around 1,100 employees.

• Skipping It . . . **North American Aviation, Inc.,** is skipping the B model in its F-86 series and is getting out a new airplane greatly superior in performance, known as F-86C. U.S.A.F. already has ordered 118 F-86C's. F-86A set a world air-speed record of 670.981 m.p.h. carrying standard armament of six 0.50-cal. machine guns and full ammunition load last September, piloted by Major Richard L. Johnson of Wright Field Flight Test Section. Average Mach Number was 0.87 in the four runs over a 3-km. course. Pilot said he never approached maximum capabilities of the plane, 690 m.p.h. being classed as routine.

• Doubles Profit . . . **Northrop Aircraft, Inc.,** netted $520,145 profit for fiscal year ended July 31, more than double the $240,573 earned in preceding year, annual report revealed.

• Flying Fedoras . . . Following up its shipments of bubble gum to South America, **Pan American World Airways** flew 1,017 lbs. of men's hats to Bogota, Colombia, from Miami. The flying fedoras, packaged in 76 compact bundles, totaled 3,175 hats valued at $21,443.

TYPHOON IN THE NOSE

Wright Aeronautical Corporation's flying test laboratory, a converted B-17 Flying Fortress, is being used for altitude testing of the Wright Typhoon T-35 mounted in the nose. The turbo-prop tests were started more than a year ago at the company's Caldwell, N.J., airport. Note exhaust pipes under fuselage.

• New Pesco Plant and Research Lab . . . A $2,650,000 production plant and research laboratory for development and production of high-precision aircraft parts is being built by **Pesco Products Division,** Borg-Warner Corporation, Cleveland. The one-story plant located on a 35-acre site near Cleveland is expected to be completed next May.

• Navions for Army . . . **Ryan Aeronautical Company** has started production on 158 L-17B Navions for the Army.

• Dividend Declared . . . **Solar Aircraft Company,** San Diego, has declared a dividend of $22^1/_2$ cents per share on 90-cent preferred stock, payable last November 15 to stock of record October 31.

• An order for 1,155 klystron tubes was received by **Sperry Gyroscope Company** from the Army Signal Corps.

• Postwar Production . . . 4,798 four-place planes have been delivered by **Stinson Division,** Consolidated Vultee Aircraft Corporation, for the postwar period through last September.

• Gourmet's Delight . . . Broiled filet mignon, fresh strawberry sundae, champagne, brandy—all this and Paris, too, await the happy traveler who boards the **Trans World Airline** "Sky Chiefs" for the French capital on the new all-sleeper transatlantic flight service opened last October 1. In addition, there will be a hot full-course breakfast served before landing in Paris, preceded by a hostess-borne eye-opener fruit juice and beverage brought to the berth-side. All-sleeper service leaves New York every Friday at 4:00 p.m. for 15-hour trip to Paris with one stop at Gander . . . T.W.A. has been cutting costs to tune of $400,000 per month for past year. Company's budgetary control program was under study at a 2-day meeting in Kansas City, called by E. F. Kelly, Executive Secretary of A.T.A. last October . . . Transfer of "turn around" maintenance operations from New Castle to La Guardia Field has been made, which effects savings of thousands of dollars annually.

• Centralized Maintenance . . . Transfer of **United Air Lines'** DC-3 overhaul shops from Cheyenne was made to provide centralized maintenance of United's entire fleet of 147 planes at company's new base at San Francisco . . . All-time cargo record was set in September when U.A.L. flew estimated 2,497,930 cargo ton-miles, 44,000 ton-miles above previous record made last June. October figure should be considerably higher, United believes.

• Atomic Power Division Formed . . . **Westinghouse Electric Corporation** has announced formation of an Atomic Power Division, which will concentrate solely on the harnessing of nuclear energy for the production of useful power.

I.A.S. Newslines

▶ Checks THE Meter . . . At recent International Conference on Weights and Measures in France, **Dr. Edward U. Condon,** I.A.S. Honorary Member and Director, U.S. Bureau of Standards, satisfied himself that no one had "monkeyed" with the world's official meter, a platinum bar held securely in a vault in Sèvres, in Paris suburbs. The inspection rite, normally held every 6 years, is first since 1933. The American copy of the Sèvres bar is kept in Bureau of Standards at Washington.

▶ Full Time Job . . . **Major General Oliver P. Echols,** I.A.S. Associate Fellow, who resigned as Aircraft Industries Association President last September, now is devoting full time to his duties as Chairman of the Board of Northrop Aircraft, Inc.

▶ **Luis de Florez,** an I.A.S. Fellow, and President of de Florez Engineering Co., Inc., is a member of the Scientific and Synthetic Analysis Committee, ad hoc group established by Secretary of Defense to examine all aspects of military activity to ascertain where scientific methods can be utilized to improve existing procedures. Committee held its first meeting last October.

▶ On N.S.R.B. . . . Former Vice-President for Public Relations for The Sperry Corporation, **R. E. Gillmor,** is Vice-Chairman of the National Security Resources Board, Old State Building, Washington, D.C. Mr. Gillmor is an Associate Fellow of the Institute.

▶ Manages New Allison Office . . . **B. T. Hulse,** Associate Fellow, has been named manager of the newly opened office of Allison Division, GM, at the Republic Aviation plant at Farmingdale, L.I. Hulse, formerly Chief Test Pilot, will handle engineering, service and sales for northeastern U.S.

▶ Certificate of Merit was awarded **Loren F. Jones,** RCA Corp. of America's Manager of Research & Development, Engineering Products Division, for services as Chief, Communication Division and member of Radar Committee of Radar Division, Office of Scientific Research & Development. In 1941 he proposed basic radar and television air navigation system now known as Teleran. Mr. Jones is an I.A.S. Fellow.

▶ Developing 25,000-Lb. Jet . . . **Carleton Kemper,** Executive Engineer of N.A.C.A.'s Lewis Flight Propulsion Laboratory at Cleveland, an I.A.S. Fellow, said jet engines with potential thrust of 25,000 lbs. or more are being developed by N.A.C.A. Under study, he said, is jet combustion chamber design that can release five times amount of heat present engines can.

▶ Daytime Mass Bombing Out . . . Tactics of last war involving daytime mass pattern bombing will be on the shelf in any future war, says **Gen. George C. Kenney,** I.A.S. Honorary Member; bombing tactics of B-36 and other heavy bombers will consist of night operations, preferably in bad weather, at altitudes around 40,000 ft. B-36 eventually will have maximum range of 12,000 miles with effective bomb load, the General expects.

▶ Agricultural Aviation Clinic? . . . **Del Rentzel,** C.A.A. Administrator and I.A.S. Honorary Member, said the use of the airplane as a tool in agriculture today is the focal point of interest of the entire aviation industry. He suggested a clinic where problems met in spraying and dusting could be studied.

▶ Installed as Legion Head . . . **Vice Adm. Charles E. Rosendahl,** U.S.N. (Ret.), was installed as Commander of American Legion Air Service Post No. 501, together with a full staff of officers at the Lotus Club, New York City, last October. Admiral Rosendahl, who is an I.A.S. Fellow, was Chief of Naval Airship Training at the Naval Air Station, Lakehurst, N.J.

▶ Author . . . **Dr. Harold W. Sibert,** Associate Fellow and Professor of Aeronautical Engineering, University of Colorado, Boulder, Colo., is author of *High-Speed Aerodynamics,* published by Prentice-Hall, Inc., last October 20. Book is said to be only one in field designed to be of particular value to engineers who have no extensive training in higher math.

▶ Guided missile research constitutes one of the major activities of the National Bureau of Standards, according to **Dr. Harold K. Skramstad,** Associate Fellow, and Chief, Guided Missiles Section of the Bureau.

▶ **Commander Carl J. Wenzinger,** U.S.N., formerly Chief Aeronautical Engineer, David Taylor Model Basin, Washington, D.C., now is Staff Engineer with Fairchild Aircraft Division, Fairchild Engine and Airplane Corporation. He is an Associate Fellow.

▶ Founder of Weems System of Navigation, **Capt. P. V. H. Weems,** I.A.S. Fellow, has taken over direct management of Aeronautical Services, Inc., Washington, D.C., as Chairman of the Board, with Thoburn C. Lyon, former Chief Cartographer of Coast & Geodetic Survey. Company compiles and publishes airways manuals and engineering services.

▶ Joins Radiophone . . . **Omer L. Woodson,** Associate Fellow, who was owner and Manager of The O. L. Woodson Company, Los Angeles, has been named Project Engineer of Radiophone Company in Los Angeles.

▶ Up from Brazil . . . **Prof. John E. Younger,** who was Professor of Airplane Structures, Instituto Technilogico de Aeronautica, Brazil, now is Head of the Mechanical Engineering Department, University of Maryland, College Park, Md. Professor Younger is a Fellow.

Meet Your Section Chairman

Richard Duncan Hiscocks

Toronto Section

Elected Chairman of the Toronto Section of the Institute in January, 1948, Richard D. Hiscocks is Design Engineer with de Havilland Aircraft of Canada Ltd. in Toronto.

Born on the eve of the first World War in 1914, Mr. Hiscocks was graduated from the University of Toronto in 1938 with a degree of Bachelor of Applied Science. While at the university he was a research assistant in the university's wind tunnel and photostatic research and also worked at de Havilland Aircraft of Canada as an Assembler, doing general shop work and metal and woodworking.

▶ **Worked on 'Flamingo'**—From July to December, 1938, he worked in England at the de Havilland plant on the assembly of the de Havilland Flamingo; he then was appointed to the National Research Council, Ottawa, as Senior Research Assistant. In that capacity, Mr. Hiscocks carried on investigations in the field of vibrations in aircraft structures in the Council's laboratories until 1940.

Named Junior Research Engineer in the Council's Aircraft Structures Laboratory, he was engaged for 2 years in the development of new methods for the construction of aircraft components in wood. He also was in charge of all static testing for the Royal Canadian Air Force and assisted with the design of wooden aircraft and components.

▶ **Head of Lab.**—As a result of his work, Mr. Hiscocks, described by his superior as an unusually able and resourceful aeronautical engineer, was placed in charge of the Aircraft Structures Laboratory of the Council.

In 1944 he wrote a paper, "Plastic Plywoods in Aircraft Construction," which appeared in the January issue of the *Canadian Engineering Journal* and in the April issue of *Transactions of the American Society of Mechanical Engineers.*

I.A.S Sections

Baltimore Section

Don K. Covington, Jr., *Secretary*

Approximately 100 members and guests attended the September 24 meeting of the Section at The Johns Hopkins University, Chairman O. J. Schaefer presiding.

Following the completion of Section business, the Program Chairman, Fred Jewett, introduced the speaker for the evening, Comdr. Paul J. Burr, Director of the Naval Air Experimental Station, Air Material Center, Philadelphia, who is also Chairman of the Institute's Philadelphia Section.

▶ **High Speed Problems**—Commander Burr's subject was "Testing and Development of Aircraft Systems and Systems and Components—Problems Dictated by Modern High Speed Aircraft."

In his address, he outlined the various functions, organization, and equipment, as well as some of the 600 active projects undertaken by the Naval Air Experimental Station.

Los Angeles Section

John C. Silliman, *Secretary*

A dinner and technical session meeting were held September 16 with Willis M. Hawkins presiding. Speaker of the evening was Robert H. Hoover, Project Engineer for the XC-99 of the Consolidated Vultee Aircraft Corporation.

▶ **XC-99 Design.**—Mr. Hoover's talk, "Design Features of the XC-99—World's Largest Landplane," was of particular interest because of his specific comments on design features. A film of taxi and flight tests of the Convair-Liner 240, XB-46, and XC-99 aircraft was shown.

Discussing in detail the salient dimensions and design of the XC-99, Mr. Hoover gave the following pertinent data: The plane has a 230-ft. span with 4,772 sq.ft. of wing area. Powered by six 3,000-hp. Pratt & Whitney R-4360-25 turbosupercharged engines, each engine driving a three-bladed prop having a diameter of 19 ft., the XC-99 has a design gross weight of 265,000 lbs. and is capable of carrying a useful load of 163,000 lbs. for the gross overload condition of 295,000 lbs.

Ratio of useful load to gross weight is extremely favorable. As the plane is intended for cargo-carrying purposes, the fact that it has two decks; 1,725 cu.ft. of usable space; and

(*Continued on page 93*)

News of Members

Louis B. Baldwin, Jr., is an Engineer Trainee at Chance Vought Aircraft Division of United Aircraft Corporation.

Clarence M. Belinn, President, Los Angeles Airways, Inc., reports that the "reliability and safety of the helicopter is virtually a proven fact," following a year's operation on AM-84 of the world's first scheduled commercial helicopter service. Called "Operation Whirlwind," L.A.A. was organized in 1944 and was granted a 3-year mail certificate by C.A.B. in May, 1947, covering 44 suburbs in 50-mile radius of Los Angeles.

Stanley U. Benscoter, who was a Structural Engineer at Langley Field for N.A.C.A., now is a Graduate Student at Cal Tech.

Arthur Braun is Aircraft Equipment Specialist in the Civil Aeronautics Administration's Region 1 office, New York City.

Raymond O. Brittan has been "on loan" to Argonne National Laboratories-AEC from Northrop Aircraft, Inc., since last August.

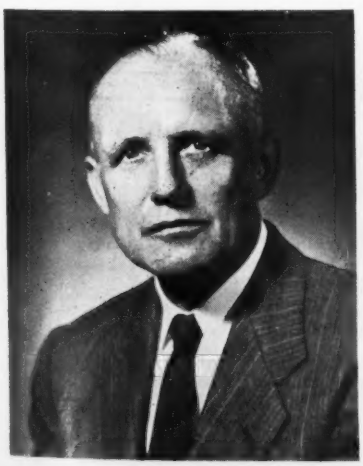
Otis J. Cofiniotis, formerly with the Pilotless Plane Division of Fairchild Engine and Airplane Corporation, is now Design Engineer at Consolidated Vultee Aircraft Corporation, Ft. Worth, Tex.

Philip R. Compton is a student at Georgia Institute of Technology, where he enrolled September 27. He formerly was Junior Engineer at Westinghouse Electric Corporation, Pittsburgh, Pa.

Preston E. Dickson is on temporary leave from Beech Aircraft to Iowa State University for further studies.

LEAR ENGINEER

G. Lester Jones has been appointed Chief Engineer of Lear, Inc., Grand Rapids, Mich. During the past year Mr. Jones served as Assistant to the President of Indian Motorcycle, Springfield, Mass., and was instrumental in setting up the new plant at East Springfield. During the war he was associated with the War Products Division of Eversharp, Inc., where his supervision was responsible for production of the Sperry Mark IV Automatic Pilot



Douglas Eastman, Jr., has been Jr. Engineer at Curtiss-Wright's Columbus, Ohio, plant since May.

Miss Isabel C. Ebel is an Aerodynamicist at Ryan Aeronautical Company, San Diego. Miss Ebel, a pilot, flies, as well as designs, aircraft.

L. Grant Ferguson is now in Hawthorne, Calif., with Northrop Aircraft as Designer "B." He had been at Republic Aviation as Flight Controls Engineer.

Dimitrius Gerdan, Chief Engineer of Allison Division, General Motors, foresees a turbopowered transport of about DC-6 size as smallest that can be used in domestic service because of fuel consumption characteristics.

R. G. Hagan is in the Engineering Department of Shawinigan Water & Power at Three Rivers, Quebec, Canada, as Electrical Technician. Previously, he had been with the U.S.A.F. at Goose Bay, Labrador, as an Electrical Engineer; he is presently writing a book on Aircraft Electrical Systems, using many of his own illustrations.

John A. Harper has entered on duty at the Langley Memorial Aeronautical Laboratory N.A.C.A., as Engineer Test Pilot.

Victor A. Ivanoff, formerly Research Engineer, Helicopter Corporation of America, is Chief Research Engineer with General Helicopters, Inc. He also is a member of the Technical Board, *American Helicopter* magazine.

D. C. Jackson is at the Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

Rudolph A. Johnson is Engineer-B.S.M.E at Curtiss-Wright Corporation's Columbus, Ohio, plant. He had been a student at Indiana Technical College, Ft. Wayne, Ind.

Walter H. Johnson, who was Program Director, Supersonic Wind Tunnel Laboratory, Aberdeen Proving Ground, Aberdeen, Md., is now with International Business Machines, where he has been in Technical Sales since September 20.

G. Lester Jones, one-time Engineering and Production Manager of Sperry Gyroscope, has been appointed Chief Engineer of Lear, Inc., Grand Rapids, Mich.

Charles H. Kaman, President, The Kaman Aircraft Corporation, has announced delivery of the first Kaman-designed and -built helicopter rotor and controls to the Navy. Acceptance of the Kaman rotor by Navy initiates the next phase of the contract which specifies that additional engineering data will be compiled through running the rotor at N.A.-C.A.'s Langley Field Lab.

Jesse J. King, Jr., resigned as Designer "B" with Douglas Aircraft (El Segundo) to accept a position as a Stress Analyst with Northrop Aircraft, Inc.

Frank L. Kovarick resigned from Ranger Aircraft Engines Division of Fairchild to enter the U.S. Naval Academy at Annapolis as Midshipman.

REALIZING DREAM

Glenn L. Martin and his mother, Mrs. Minta Martin, on the ramp of the Martin 2-0-2 at the Martin Airport just before taking off on first leg of an aerial tour to West Coast, realizing a dream of 40 years. The Martins covered more than 6,500 miles in the trip.

Brigadier General Frank P. Lahm's new hometown is Hollywood, Calif. He moved from Mansfield, Ohio. General Lahm is the new President of the Early Birds.

Allan L. Lubin resigned from Chance Vought Aircraft Division of United Aircraft last September to accept a position with McDonnell Aircraft Corporation. He now lives in Pattonville, Mo.

James K. Marstiller has been B-45 Project Engineer, Procurement Division, Air Materiel Command, Wright-Patterson Field, Dayton, Ohio, since June, 1948.

Harry M. McKay, formerly General Manager of Fairchild Personal Planes Division, is President of McKay Metal Products Company, manufacturing roll shapes for aircraft and aircraft engines.

J. E. McNally, who was at the Corpus Christi Naval Air Station, is now at Wright Field in Bomber Procurement, Dayton, Ohio.

J. F. Meade is the owner of Mercury Aircraft, Inc., working on tanks and control surfaces.

Jay L. Musil is with the N.A.C.A.'s Instrument Research Division and lives in Hampton, Va.

Carl Norcross, Member of Editorial Board, Time, Inc., wrote the script of March of Time movie, *America's New Air Power*, recently released. Newest jets—experimental, fighter, and bomber—are shown, including some beautiful shots of the McDonnell XF-85 parasite in action.

Stanley Novak is in Flight Test at the Naval Air Test Center, Patuxent River, Md. He was with Chase Aircraft as Flight Test Engineer.

(*Continued on page 96*)

1948 **January** 1948

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

1948 **May** 1948

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23/30	24/31	25	26	27	28	29

6TH ANNUAL WINTER MEETING NYC

1948 **February** 1948

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29						

1948 **March** 1948

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

4TH ANNUAL PROPULSION MEETING

1948 **April** 1948

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

5TH ANNUAL PERSONAL AIRCRAFT MEETING

1948 **June** 1948

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

1ST MEETING ON WINGS!

Year-End Report

After taking your first look at these pages, *don't* rush off to see your eye doctor. The chances are that the "spots" you see are meant to be there. They merely indicate that you—as a member of the I.A.S.—belong to an extremely active technical society.

Each of the black dots over a date on the 1948 Calendar stands for at least one I.A.S. Section Meeting held on that day. Some of them represent two or more meetings. The small figure attached gives the actual number. (Note that there were *four* on June 9!)

Superimposed, in red, are the regular National meetings of the Institute. With one exception (the Joint Meeting with the Soaring Society of America on July 1), they have all been regularly recurring features of our meetings program for many years.

If you add up all the regular section meetings and the national meetings and strike an average over the 365 days of the year, you will find that every 3 days—year around—some scheduled Institute activity was in progress somewhere on the North American Continent (we have included our Canadian meetings, of course).

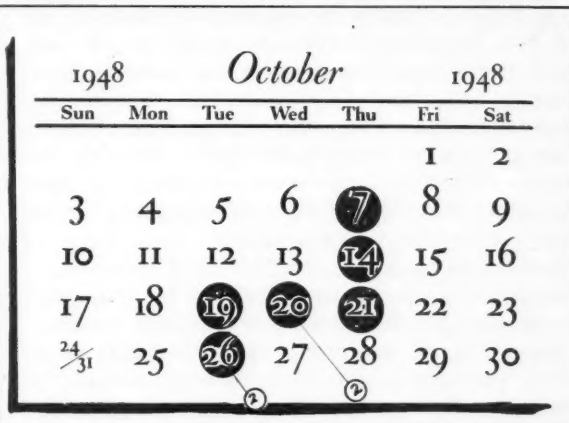
But that isn't quite all. In addition, our 61 Student Branches held an average of over five meetings apiece during the year. If you toss these into the average, the figure comes out as better than one-a-day.

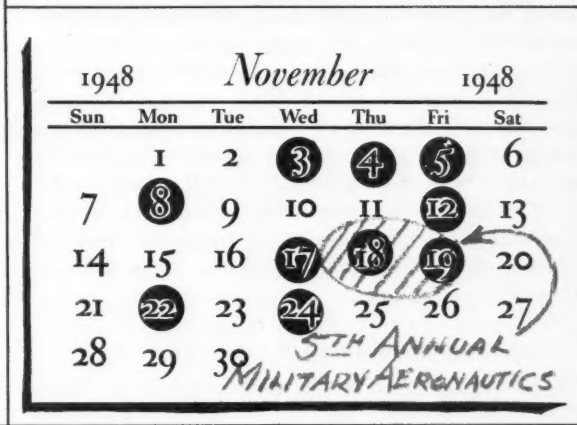
Since January 1, 1947, our total membership has increased from about 8,100 to over 10,500. Organized Sections have increased from 13 to 17; Student Branches, from 38 to 61.

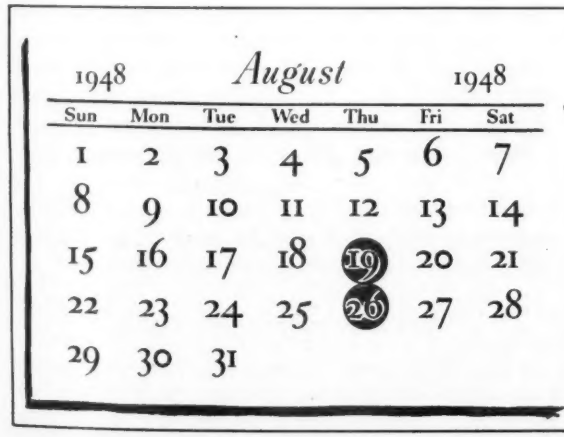
So—we think you will all agree—your Institute is very much in the business of serving the professional needs of its members.

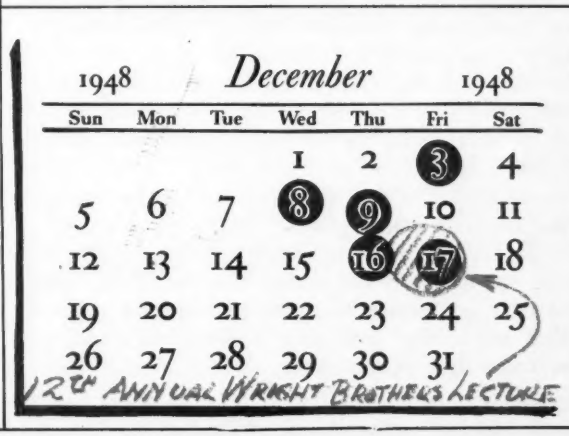
In spite of an increasing tempo of activities, we are glad to be able to report again that our fiscal position is sound. You recall that we closed our books on September 30, 1947, "in the black" by a small margin. This year (September 30, 1948), we came up with a small deficit, due largely to unexpected increases in costs of services and materials all along the line. The exact figure will be reported in our annual Treasurer's statement in February, but it will be of the order of $3,000—about *1 per cent* of our annual operating budget—practically a "break-even" condition these days.

Altogether, we have had a good year. With the continuing support of the membership, 1949 will be even better. S.P.J.









An Inert Gas Installation for Aircraft Fuel Tanks

HOWARD W. NAULTY*
Cornell Aeronautical Laboratory

Introduction

At the outbreak of hostilities with the Axis, one of the points of discussion among aircraft men, both tactical and armament, was the vulnerability of aircraft fuel tanks to shot and shell. This problem became of sufficient importance to warrant the expenditure of time and money in its study. When the fuel tanks were full, the danger of fire or explosion was slight, but as the level of the liquid in the rank receded, it was replaced with air from the outside. Part of this air immediately absorbed quantities of gasoline vapors forming an air-fuel mixture in the tanks which, with certain temperatures and pressures, was definitely combustible. It was proved that this danger period covered a major portion of the time the aircraft was aloft, both by oxygen sampling and by actually firing Allied and Axis ammunition of various calibers and types at both Allied and enemy fuel tanks placed on the ground and filled with combustible mixtures of Allied and German fuels. It had been common knowledge that the danger of explosion of fuel-air mixtures was greatest when the oxygen content was between 14 and 17 per cent, varying slightly with the temperature.

Therefore, it became desirable to develop a method of reducing the oxygen content of the space above the liquid, in aircraft fuel tanks, below that point sufficient to sustain combustion.

Methods Tried by the Allies

A brief description of the work done by the Allies is appropriate at this time to set the background for the development described herein. After extensive study of the solubility of various inert gases with gasoline and the cooling rates as they affected absorption of these gases, it was decided to test two methods of obtaining inert gas for the fuel tanks: (a) engine exhaust and (b) bottles of compressed nitrogen. In the engine exhaust system, a tube facing forward in the exhaust stack removed a small quantity of the engine exhaust, which was passed through chemical absorbers to remove the moisture and carbon dioxide. (The latter was removed because there was considerable concern about the increased possibility of vapor lock caused by the carbon dioxide being absorbed in the fuel.) From this point, it was led directly into the fuel tanks, allowing the entrance of the inert exhaust gas to purge the air from the tanks through the tank breather or vent line at the far end of the tank. The second, or bottled nitrogen system, involved the use of a modified oxygen valve to regulate the flow of nitrogen to the tanks. This valve was set to permit a flow of approximately 4 cu.ft. per hour and was opened manually during dives to allow a flow of 55 cu.ft. per hour. This system was also of the purge or continuous-flow type.

It was found that both of the above methods lowered the oxygen content of the tank during level flight, although the end of the tank farthest from the inert gas inlet was 3 to 9 per cent higher than at the entrance point. For example, at the conclusion of one dive, the oxygen content had risen to 18.9 per cent at the far end and 13.5 per cent at the inert gas inlet end of the tank. This was a result of the reduction in volume of the vapors over the liquid caused by the increase in atmospheric density as the plane descended, which lowered the relative pressure in the tank creating a demand for inert gas at a rate greater than the system could deliver. As a consequence, instead of the continual purge, as was the case in level flight, air entered the tanks through the breather vent tubes.

Because of the short life of the chemical absorbers and because actual flight tests had indicated that the danger of vapor lock from carbon dioxide in the fuel was not so great as had been anticipated, it was decided to use a moisture condenser in the exhaust gas system to remove the water by lowering the temperature.

It was further decided to modify the bottled nitrogen system by a series of delicately adjusted valves that were planned to control the flow at either end of the tank so that, in the case of a sudden increase in demand, nitrogen could enter from both ends simultaneously.

Flight tests with this tank venting gave unsatisfactory results at the completion of a dive with the exhaust gas system. The valves were so delicately adjusted in the bottled nitrogen method that the least amount of ice or dirt rendered that system inactive.

Demand on Inert Gas System

With this information as a background, let us briefly consider the demand for inert gas made by the fuel tanks of an airplane with a gasoline capacity of 1,440 gal. and having two Pratt & Whitney R-2800 engines,

Presented at the Aircraft Design Session, Sixteenth Annual Meeting, I.A.S., New York, January 26–29, 1948.

* Development Engineering.

as in the case of the C-46 used in the tests in this country.

Engine Consumption[1]

At slightly above cruising speed with the engines turning at 2,100 r.p.m. delivering 1,154 hp. at 5,000 ft. altitude, each engine consumes 614 lbs. of gasoline per hour. Converting pounds to cubic feet, a C-46 would have a fuel consumption of 27.36 cu.ft. per hour at cruising speed and 42.2 cu.ft. per hour at maximum continuous speed. These figures would give a flight time of 7.05 hours at cruising speed and 4.57 hours at maximum continuous speed. However, it may be necessary for the aircraft to fly at maximum continuous speed on occasions. When this is necessary, it will undoubtedly be in the presence of enemy bombardment when fire prevention would be most urgent. It is therefore indicated that the accepted generator or other source must be capable of continuously supplying inert gas at the same rate as the fuel is withdrawn from the tanks. Hence, the figures of 42.2 cu.ft. per hour for 4.57 hours or 27.36 cu.ft. per hour for 7.05 hours must be used to determine the volume of the inert gas required for engine consumption.

Fuel Tank Breathing with Altitude Changes

Now let us consider fuel tank breathing due to changes in altitude. In order to allow for the maximum demand, assume the aircraft in question to be at 25,000 ft. with nearly empty fuel tanks and descending at a rate of 2,000 ft. per min., vertical velocity, through a barometric pressure change of a half atmosphere. The rate of fuel temperature change would vary with each particular airplane structure, so let us consider both extremes and take the worse condition. Since the atmospheric change is through a half atmosphere, ignoring temperature, and since the volume of the tanks is 1,440 gal., which is 192.6 cu.ft., the new volume will become 96.3 cu.ft. at 3,800 ft. altitude, which represents a half atmosphere from 25,000 ft. This is an altitude change of 21,200 ft. At 2,000 ft. per min. vertical velocity, a dive would require 10.6 min., during which time 96.3 cu.ft. of inert gas would be required to fill the tanks, which is a rate of supply of 9.09 cu.ft. per min. (which is 624 cu.ft. per hour as compared with 42.2 cu.ft. per hour for maximum engine consumption). Thus the problem of tank breathing is much greater than engine consumption.

This explains the sudden increase in oxygen content at the end of the dives in the British tests described earlier.

Generator Installation as a Source of Inert Gases

Through the National Defense Research Council acting for the Office of Scientific Research and Development as the coordinating agency for the U.S. Navy and the Allies, the Curtiss-Wright Research Laboratory was asked to evaluate two types of inert gas generators being developed in this country and the use of exhaust gas preparatory to engaging in an actual experimental installation program. One of the generators involved the principle of residual nitrogen from the air. It was in the laboratory state and was not considered practicable for aircraft installation. The other depended on burning pure carbon to give off carbon dioxide. While this type probably would serve the purpose it was considered too hazardous to use.

Bottled Gases—Carbon Dioxide and Nitrogen

In view of the work done by the Allies on the use of bottled gases, it was decided to include carbon dioxide and nitrogen in this evaluation. Considering first carbon dioxide, it was found to be easily compressible and could be carried in bottles at a pressure of 10 atmospheres. Because it can be compressed to $^1/_{450}$ of its original volume, it would require a small container. This is an important point because of the wall thickness necessary for a container to carry 10 atmospheres pressure.

Carbon dioxide is more soluble in gasoline than nitrogen, therefore, it is less desirable from the standpoint of possible vapor lock as it is freed from the fuel at altitude. Because of the pressure under which it is carried, it introduces the danger of enemy fire hitting the bottle, which would explode with as much violence as the actual shell. Thinking next of nitrogen, it was found to be much lighter than carbon dioxide but not so compressible. It would require 70 lbs. of carbon dioxide to protect a 1,440-gal. tank while only 24 lbs. of nitrogen would give the same protection. These figures include an additional quantity to allow for the fact that a certain amount of the gas would be dissolved in the fuel. Although N_2 is lighter, it is less compressible and requires a larger metal cylinder. The gas weights and solubility figures favor the use of nitrogen, but when the entire equipment was considered, it was found to weigh 181 lbs. for the carbon dioxide unit and 185 lbs. for the nitrogen.

Perhaps the most deterring factor to the use of bottled gases was the fact that it would be necessary to have a generator or some other source of supply at each airfield. It would also be necessary to service the system after each flight, which would greatly add to the already numerous chores of the ground personnel. It became evident that, if any system were to be used, it should be automatic in operation and should not require ground services except for occasional cleaning. In view of these facts, it was felt that any obstacles that might be encountered in the engine exhaust system would be less difficult to overcome than the logistics involved in the use of any of the generator or bottled gas systems described above.

Availability of Engine Exhaust Gas

The first question to be answered was the availability of the engine exhaust at the time it was most needed. That is, in a dive, when the demand for inert gas would

CHANGE 5 ATMOSPHERE AT 2000 F P M	COPPER REGENERATIVE	CARBON COMBUSTION	BOTTLED GAS CO_2	BOTTLED GAS N_2	ENGINE EXHAUST
1 WEIGHT COMPLETE	70 LBS	1416 LBS	181 LBS	185 LBS	5360 LBS
2 GAS GENERATED	N_2	CO_2	CO_2	N_2	MIXTURE
3 SOLUBILITY OF GAS	LOW	HIGH	HIGH	LOW	?
4 STARTING METHOD	AUTOMATIC	NOT DEVELOPED	AUTOMATIC		AUTOMATIC
5 STOPPING METHOD	"	CANNOT STOP	"		"
6 CONTROL	SIMPLE	SIMPLE	"		"
7 AUTOMATICITY	GOOD	POOR	GOOD		GOOD
8 SOURCE OF GAS	AIR	FREE CARBON	GENERATOR ON GROUND		ENGINE EXHAUST
9 ATTENTION ON GROUND	100 HRS	8 HRS.	8 HRS		100 HRS
10 LIFE PER CHARGE	500 HRS	8 HRS	8 HRS		INDEFINITE
11 OPERATING TEMPERATURE	700°C	1300°C	LOW		UNDETERMINED
12 DANGER OPERATING	NONE	EXTREME TEMPERATURE	NONE		NONE
13 DANGER IF HIT BY SHELL	SLIGHT	POSSIBLE EXPLOSION	NONE		NONE

FIG. 1. Comparison of four sources of inert gases.

be greatest. In the case of large planes, the so-called dive is really a steep glide, and for that reason the engines are operated at a point sufficient to keep them warm and are occasionally speeded up to clear them of excess gasoline. Thus, when the demand is greatest, the exhaust output is at the lowest.

Examination of engine data revealed that the temperature of the exhaust varied from 1,200° to 1,800°F. dependent on the horsepower setting. The average fuel-air ratio was 0.067, and the fuel consumption varied as much as 1,300 lbs. per engine per hour in level flight to approximately 100 lbs. per engine per hour in dive or glide setting. Therefore, since it would be desirable, and sometimes imperative, that only one engine exhaust be used and since the demand is greatest when the available exhaust is least, 100 lbs. fuel + 1,500 lbs. air = 1,600 lbs. total per hour or 26.6 lbs. per min., or approximately 346 cu.ft. per min. Therefore, at lowest possible engine speeds, the rate of inert gas production would be more than 30 times the greatest possible demand rate.

It was felt that an exhaust gas system could be installed that would weigh approximately 38 lbs., complete.

Closed Tank System

The weight, however, was based on a modified fuel tank installation termed the "closed" system. In order to keep the inert gas demand at the lowest point and to reduce the amount of carbon dioxide that could be absorbed by the fuel as well as to keep the corrosive substances to a minimum, it was felt that some changes should be made in the conventional method of tank venting. The alterations consisted of rerouting the tank vent lines to a single manifold, which led to the engine exhaust stack, having a check valve in it to prevent back flow from the tank to the hot stack. Between the check valve and the branch of the tank feed lines there would be a pressure relief valve and a vacuum breaker valve. The adjustable relief valve would operate during climbs to keep the pressure differential between the tank and the ambient atmosphere at a desired setting. The vacuum breaker would only serve as an emergency valve in case something should plug the feed line which would cause a back pressure in the tanks and would starve the engine to the stalling point. In short, the tanks would be vented through the engine exhaust stack with a check valve and a vacuum breaker valve as an emergency measure.

A comparison of the various systems is shown on charts, Figs. 1 and 2.

At a conference attended by representatives of the various governments, the National Defense Research Council, and Curtiss-Wright, it was decided to make further tests on the exhaust gas method using the closed fuel tank system.

As a result of the conference in Washington, a contract was signed for the "Development of Temporary Installation to Apply Exhaust Gases to Inert the Vapor Space in Aircraft Fuel Tanks."[2] To do this, exhaust gas taken from the collector ring was cooled in a heat exchanger, passed through a flame arrestor, and thence into the fuel tanks, after passing through a check valve at the inlet to prevent the possibility of gasoline vapors finding their way back into the hot heat exchanger with probable explosive results.

The internal pressure caused by the reduction in barometric pressure during ascent was relieved through a pressure relief valve at the highest point of the tank in flight attitude. As a safety factor, a vacuum breaker valve was installed on the inlet line, adjacent to the tank, to prevent the possibility of starving the engines. Should the heat exchanger or other apparatus become clogged to the extent that it would prevent the flow of exhaust gas, air would be admitted through this valve to replace the volume of gasoline consumed by the engines. This would also serve to prevent self-sealing fuel tanks from collapsing under internal vacuum because of their construction.

Since previous investigation of this subject was limited, the method of attacking the problem was one of caution and slow approach. Because of the fact that experimental flight time was at a premium and that

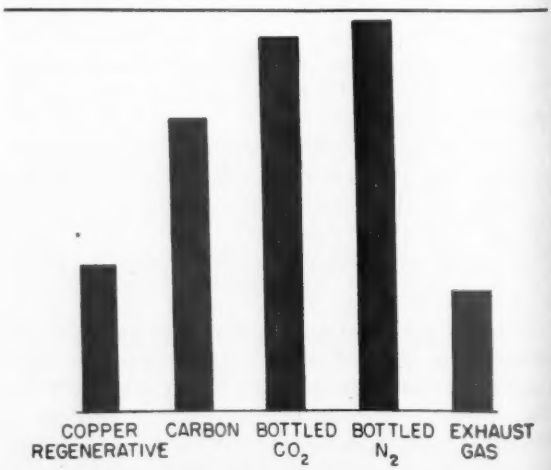


FIG. 2. Comparison of generator weights.

there could be no mutilation of the ship's structural members to accommodate this equipment, it was deemed advisable to split the procedure into two parts: a ground test and a flight test.

A brief description of equipment and instrumentation is as follows.

Description of Equipment

The exhaust gas is taken from the engine collector ring by means of a stainless-steel scoop and passed into the heat exchanger, equipped with necessary drains for the condensate from the exhaust gas. From the heat exchanger, the cooled gas is passed through a flame arrestor and check valve directly into the fuel tanks. There are two tanks, one located directly above the other and interconnected by means of a valve and suitable piping. The top tank is equipped with relief and vacuum breaker valves.

Fuel consumption was simulated in the ground tests by "cracking" the interconnecting valve located between the top and bottom tanks. By marking various positions on the valve from closed to open and precalibrating these settings in gal. per min., a given fuel consumption could be simulated by opening this valve to the desired position, thus permitting gasoline to drain from the upper to the lower tank.

For conversion of this "closed" system to the continuous bleed (or open) system, it was necessary to close the valve between the relief and vacuum breaker valves and the tank and to open the purge valve located at the aft end of the top tank. Opening of the latter valve allowed the excess gas to bleed into the atmosphere.

Two types of heat exchangers were tested during the ground tests. The first type was of the counter-parallel flow concentric cylinder type. The second type, consisting of $^3/_{16}$-in. diameter tubes, was based on the standard cross-flow principle.

Description of Instrumentation

A thermocouple was located on the exhaust gas scoop to indicate tail-pipe temperature and record this temperature on a potentiometer. A manometer connection was also located in the exhaust tailpipe to secure the necessary data on the ram pressures encountered in this vicinity. Manometers were located on each side of the heat exchanger, one located on the inlet side of the exhaust gas chamber and the other on the outlet side to determine pressure drop through the heat exchanger. A thermometer was located in the cooled exhuast gas stream on the heat exchanger for determination of this temperature. Rotameters indicated the flow of exhaust gas into the tanks. These rotameters were interconnected with necessary valves so that the exhaust gas flow could be valved to one or the other as conditions required. It was found necessary to employ two rotameters because of wide range of flow.

The instruments on the air side of the heat exchangers for determination of the pounds of air flowing per minute and necessary air temperatures were as follows:

An air-speed indicator and pitot tube were located in the slipstream so that the velocity of the air through the exchanger could be determined. Thermometers were located in the entering cooling air and exit cooling air for determination of temperature rise through the exchanger.

Instruments on the fuel tanks consisted of two thermometers located at each end of the top fuel tank, specimen valves also at each end of the fuel tank, and the manometer located on the top fuel tank to indicate pressure or vacuum in inches of water. Varying conditions of fuel flow could be checked quickly by the level of liquid in the calibrated gage glass located on the bottom tank. A filter and pump were used for returning the fuel from the lower to the upper tank. A valve located in the bottom tank was used to vent the lower tank.

Gas samples were drawn off, as required, from each end of the upper tank. A portable Fisher technical gas analyzer was used for the analysis of the exhaust gas samples. The carbon dioxide was quantitatively absorbed in caustic soda, and the oxygen was absorbed in alkaline pyrogallol. In a few samples, carbon monoxide was quantitatively absorbed in cuprous chloride solution.

Results of Ground Test

Tests on three heat exchangers were conducted, using a C-46 airplane. Telephone communication was maintained between the cockpit and the members of the Inert Gas program personnel, the watches of the latter were synchronized, and the necessary readings were taken at predetermined times so that data and samples would be uniform.

The first runs were made using the 100,000 B.t.u. primary surface heat exchanger.

This exchanger performed in a satisfactory manner, having a pressure drop that varied from $^3/_4$ to $1^1/_2$ in. of water, depending upon the horsepower conditions of the engine. Inertness of the tank was maintained well under the safe limit of 12 per cent oxygen. Equilibrium conditions inside the tank varied considerably from one end to the other, possibly because of the internal arrangement of the baffles.

The 100,000 B.t.u. per hr. primary surface heat exchanger was replaced with a cross-flow tubular heat exchanger and then ground tested. After about 2 hours of operation, the pressure drop rose from $1^1/_2$ to $4^1/_2$ in. of water, and the oxygen content exceeded the safe limit. The exchanger was removed, disassembled, and examined. The tubes that were $^1/_4$ in. in diameter were found to be clogged with carbon and foreign matter, which retarded the exhaust gas flow. Several air leaks were also found in the transition pieces where the latter were attached to the core.

This test led to the abandonment of further experimentation with this type of heat exchanger and elimi-

nated the consideration of the small tube cross-flow exchangers.

The cross-flow heat exchanger was replaced by a 40,000 B.t.u. per hour primary surface heat exchanger, and the ground-test procedure was conducted. The results were unsatisfactory. A pressure drop across the exchanger of $3^1/_4$ in. of H_2O was obtained which was far in excess of the specifications. Considerable difficulty was encountered also in maintaining an inert atmosphere in the tank under all operating conditions. Further investigation disclosed that air leaks in the system permitted air from the atmosphere to penetrate and dilute the inert gas supply. The leaks were sealed and the inlet pipe was enlarged to $1^1/_4$ in. diameter, as recommended by the manufacturer. Subsequent tests proved this repaired exchanger to be entirely satisfactory. It was exactly the same in design as the 100,000 B. t.u. per hour heat exchanger, deviating only in proportional dimensions.

The 100,000 B.t.u. per hour primary surface heat exchanger had the minimum pressure drop and gave the best results, while the cross-flow heat exchanger, because of its construction, gave the least satisfactory results.

From the results of the ground test, it was decided to design and fabricate a new type of counterflow heat exchanger to operate at an inlet temperature of 1,475° F. and to reduce 11 cu.ft. of air per min. to 70°F. at the outlet end. This heat exchanger was to have a pressure drop not in excess of $^1/_4$ in. of water. It was so designed that it could be easily taken apart for cleaning. It was felt that omission of the backpass and the careful design of an inlet and outlet tangential to the cylinders would give a minimum pressure drop and a maximum cooling effect as the gases were forced to spiral the entire length of the cylinder.

Flight-Test Installation

The same equipment used in the ground tests was slightly modified and placed inside the fueslage of an R-5-C airplane. In this installation every precaution had to be taken to avoid mutilation of the structure of the ship in any way. Because of this requirement, it was necessary to modify the escape hatch doors, to use existing lightening holes for pipe runs, and to design special clamps and brackets.

The flight installation consisted of this same equipment with the following configuration.

Scoop

The scoop was welded to the end of a 1-in. standard pipe size stainless steel line placed inside the engine exhaust tailpipe. It was fabricated from 14-gage, 18-8 stainless steel and was shaped like a funnel; the small end was about the same diameter as the stainless-steel line. The opposite end funneled out at about a 30° included angle, so that the area at the larger end was approximately 10 per cent greater than the line. The location of the scoop was determined by sliding it in and out of the tailpipe and finally locating it at the point giving the greatest ram pressure in the scoop. When the depth that gave the highest reading was found, the position of the scoop was measured by the inch markings on the stainless-steel pipe (1), using the outboard edge of the exhaust stack as a reference point. Thus, the same scoop position could be duplicated from day to day. The deleterious effect of the back pressure on the engine caused by this scoop did not exceed 12 in. of water (approximately 0.5 lbs. per sq.in.). The turbosupercharger exerts a back pressure of at least 12 in. of mercury (6 lbs. per sq.in.).

Heat Exchanger

Two general types of heat exchangers were used in these experiments. The first or counterparallel flow type was the 100,000 B.t.u. per hour heat exchanger. It was constructed of 25-12 stainless steel and was a modification of the existing cabin heater type used on the R-5-C airplane. Drains were provided in the inner and outer cylinders so that the condensate might be drawn off as required. Weighing 11.25 lbs., it was approximately 30 in. long and 8 in. outside diameter, with a 1-in. diameter inlet and $2^1/_4$-in. diameter outlet for the exhaust gas. The cooling air flowed between the concentric cylinders. The pass in the exchanger between the inner and outer cylinder caused a pressure drop but also gave added protection for any backfire, live carbon spark, or torch from the engine. It was felt that a heat exchanger with required surface and a single pass would give a smaller pressure drop but not such good fire protection. Two models of this type of heat exchanger were successfully tested, the essential difference being in the overall size. The second heat exchanger of this type was the 40,000 B.t.u. per hour R-5-C cockpit heater with a few changes. The modifications consisted of changing the size of the inlet exhaust line from 1 to $1^1/_4$ in. to minimize the pressure drop and removing the heater assembly. The weight of this exchanger was 7.3 lbs., the material being the same as described above.

The Curtiss-Wright Research Laboratory heat exchanger was similar to the primary surface type originally tested. It had a single pass, counterflow, consisting of two concentric cylinders forming a gas chamber approximately 28 in. long and 8 in. mean diameter. The exhaust gas entered tangentially through an inlet mounted 4° off the perpendicular to a line on the cylinder parallel to the axis, imparting a helical path to the gas that left the heat exchanger at the far end through a tangential exit. Thus, we were able to take advantage of a maximum cooling surface with a minimum of space and pressure drop. Provision for removal of condensate was made by locating a small drain line at the outlet end at the lowest point of the circumference. An inner and outer cooling air jacket was provided by additional concentric cylinders, the inner one having a cone at each end to assure contact of the cooling air with the inner gas cylinder.

The entire construction was of 18–8 stainless steel, although in a production model the inner and outer air jackets could be made of aluminum or one of its alloys to conserve weight. This type of heat exchanger gave a pressure drop of $^1/_8$ in. of water and could be readily adapted to the space in an R-5-C engine nacelle where the heat from the engine would prevent freezing of condensate. A cooling air line could be brought in from the bulkhead ahead of the engine cylinders without adding additional drag.

The exchanger was so constructed that it was only necessary to remove the clamping rings at each end and withdraw the inner and outer gas cylinders in opposite directions to expose the surfaces for cleaning.

Flame Arrestor

The flame arrestor consisted of alternate corrugated and flat sheets of cupro nickel. It was about 3 in. in diameter and about 1 in. thick. The individual honeycomb spacings were triangular in shape (each side was about $^1/_{16}$ in. long, forming a leg of an equilateral triangle). On each side of the honeycomb a conical-shaped transition piece funneled down at about a 60° included angle to the required pipe size. This flame trap was tested in the Laboratory by passing a bunsen burner flame about 1 ft. long through the trap. The latter effectively arrested the flame. Because of its large honeycomb cells, the pressure drop through the trap was comparatively negligible. Corrosion effects were unapparent after 30 hr. of operation.

By locating this piece of equipment in the nacelle on the cool side of the heat exchanger, it was possible to reduce its size and heat conduction requirements, inasmuch as the heat exchanger itself should stop all but the extreme torches or backfires from the engine. By locating it in the nacelle, the heat from the engine would preclude the possibility of freezing any moisture that it might condense out of the exhaust gases passing out of it. It was felt that there would be a far greater possibility of its clogging up if it were placed on the hot side of the heat exchanger, where it would strain out all of the particles of carbon and foreign matter in the engine exhaust.

Check Valve

Two types of check valves were tried. The first consisted of a $^3/_4$-in. swing-flapper type check valve originally designed to operate in either a horizontal or vertical position, and it was modified slightly by removing the spring and placing the valve in a vertical rise of the pipe. In this position, and without the spring backing, it was possible to lift the flapper with a slight pressure. Satisfactory operation was not obtained because the modified valve had a small pocket adjacent to the flapper in which condensate collected and caused malfunctioning. The pin on which the flapper swung was not of the proper material, but we were forced to use it because of the press of time.

Later this valve was replaced by $^3/_4$-in. fuel line check valve used on the P-40 (Curtiss #87-44-908), which consisted of two bronze housings with an aluminum connector and a SAEX4130 steel flapper 0.064 in. thick. Its operation was satisfactory when placed in a vertical rise adjacent to the fuel tank. Under test, this valve operated on less than $^1/_4$ in. of water pressure and was extremely sensitive. It was small, compact, and light.

Fuel Tanks

The fuel tanks consisted of an R-5-C all-riveted wing tank cut in half. The two halves were mounted on a suitable dolly and located one over the other. The tanks were modified to suit the necessary equipment and instrumentation used in connection with the project by welding in the required outlets. The baffles, sumps, bulkheads, etc., were allowed to remain as per the original design, so as to simulate actual operating conditions insofar as possible.

Vacuum Breaker

The vacuum breaker was brass with a spring adjustment so as to break at a pressure differential of $^1/_4$ to $^3/_4$ lbs. per sq.in. (6–18 in. of H_2O). In our ground tests the vacuum breaker was calibrated to break at a differential pressure of $^3/_4$ lbs. per sq.in. (18 inches of H_2O).

This same setting was used in the first flight tests. The setting was made high deliberately to force the tanks to draw in exhaust gas rather than to allow air from the atmosphere to breathe into the closed system.

Later, representatives of the Bureau of Aeronautics and members of the National Defense Research Council requested that consideration be given to a vacuum breaker that would relieve at a minimum positive pressure of 2 in., so that the system could be applicable to self-sealing tanks. These tanks cannot tolerate too great a vacuum without danger of collapse or fatigue that might lead to failure at a later date. The vacuum breaker was consequently replaced with the Curtiss check valve #87-44-908 previously described. The valve was mounted in a vertical position so that positive pressure on the outside would cause the latter to lift immediately when the pressure inside the tank dropped below the required value.

Pressure Relief Valve

The pressure relief valve as originally designed was set to relieve from 1,215 to 1,350 lbs. per sq.in. It was modified by replacing the spring with one of suitable design and adding a longer adjusting screw so that the required pressures could be set quickly. Because of the length of the longer adjusting screw, the top cap of the valve was omitted. The valve functioned satisfactorily until it was exposed to moisture, which caused the steel ball to rust. It was felt that, if a suitable alloy had been substituted for the steel, this valve would have given satisfactory operation. In the

ground tests both the pressure relief valve and the vacuum breaker were placed on top of the tank where they could be observed readily. On the flight-test installation, both the vacuum breaker and relief valve were placed outside the hatch door and were faired with a suitable streamlined fairing, so that actual slipstream temperatures would be encountered.

Results of Flight Tests

Flight tests on three types of heat exchangers were conducted, using an experimental R-5-C airplane.

Examination of these test reports indicated that the "closed" system gave ample protection under all flight conditions, whereas the "open" system failed during the dive when the oxygen content rose to a value in excess of 12 per cent. The failure to maintain an inert tank during the dives substantiates the results of the foreign tests. The tanks as used in the flight system were actually an R-5-C wing tank cut in half and the ends closed with bulkheads; therefore, the 12 per cent found at the exit end of the "open" system actually represented the middle point of the tank had it been in a permanent installation. Since oxygen content at the inlet end was approximately 4.3 per cent it can readily be seen that the entire exit half of the tank would be in the danger zone with the "open" system.

The 40,000 B.t.u. per hour primary surface heat exchanger was tested using the "closed" system and gave excellent results. An extremely small pressure drop ($^1/_2$ in. of H_2O) existed across the exchanger.

The 40,000 B.t.u. per hour heat exchanger was replaced with the 100,000 B.t.u. per hour heat exchanger, and two dives were made. Satisfactory results were again achieved; the oxygen content was held below 12 per cent in the "closed" system. Using the "open" system, however, it was impossible to maintain a "safe" tank. The exchanger had $1^1/_2$ in. of water pressure drop, thus duplicating the results of the ground-test data.

The Curtiss-Wright Research Laboratory designed counterflow, single-pass heat exchanger was substituted for the 100,000 B.t.u. per hour heat exchanger. It was similarly flight-tested by diving from 25,000 to 10,000 ft. at an average rate of descent of 2,000 ft. per min. This exchanger gave the minimum pressure drop ($^1/_8$ in. of H_2O). An inert tank was maintained during all flight conditions.

A second dive was made with this equipment, modified to meet the specifications set up by the Navy, to keep a positive pressure inside the tank during all flight conditions. The necessary design changes were made by replacing the existing original vacuum breaker with a Curtiss $^3/_4$ in. fuel line check valve in an inverted position. With these changes, a pressure of 5 in. of water was maintained during a dive from 25,000 to 18,000 ft., 0 in. of H_2O from 18,000 to 15,000 ft., and $-^1/_4$ in. of water pressure from 15,000 to 13,000 ft. The rate of descent varied from 1,500 to 3,000 ft. per min., averaging about 2,000 ft. per min.

Details of Corrosion Investigation

The laboratory corrosion investigation consisted of the determination of the corrosive activity of the condensate drawn from the heat exchangers. The tanks, heat exchangers, and connections were also cut up and examined after flight testing. No corrosive effects were found that could not be eliminated in a permanent installation.

Early in 1946 a proposal for a complete flight installation was made to the U.S. Navy, and a contract was granted a short time later. This installation was made on a PB4Y-2 Airplane furnished by the Navy.

The work was divided into two phases, namely: (a) wing and fuselage fuel tanks and (b) the space around the tanks inside the wings.

This airplane resembles the B-24, with a slightly longer fuselage and a single tail fin, and is equipped with four Pratt and Whitney R1830 Engines. The fuel is carried in six self-sealing fuel cells in each wing. These cells are located between the two inboard engines in a chamber that is purposely constructed to be leakproof.

A $1^1/_2$-in. diameter tube was welded into a bend in the exhaust stack near the outlet end in such a position that it received the full ram pressure of the exhaust gas. This tube conducted the exhaust gas to a heat exchanger of the cross-flow tubular type, having approximately 47 sq.ft. of cooling area using tubes $^7/_8$ in. in diameter. An actuator-driven butterfly valve was located in the cooling air outlet tube of the heat exchanger and controlled by thermal bulbs in the exhaust gas outlet side of the heat exchanger. This valve was necessary to prevent freezing of the condensate from the exhaust gas in the heat exchanger when the exhaust gas demand was low and the cooling air would be cold because of high altitudes.

From the heat exchanger, which was located in No. 1 nacelle, a manifold was run to the No. 2 nacelle where a lift-type check valve was located to prevent backflow of the gases into the heat exchanger and the exhaust stack. A pressure relief valve set at 12 in. of water and a vacuum breaker valve set at -2 in. of water, differential pressure, were located just above the check valve. From this point, a distribution manifold carried the exhaust gas to the fuel cells, being connected to the original vent line.

All major openings in the wing were closed off, and exhaust gas outlets were located around this compartment to inert the space around the fuel cells.

In order to check on its efficiency, ground tests were made on the heat exchanger and the cooling air valve. A 120-hp. gasoline engine driving a 54-in. blower was used as a cooling air supply and the exhaust from the engine was led into the heat exchanger. Calibrated venturis were placed in the outlet of the exhaust gas and cooling air so that the pressure drop across each side of the heat exchanger could be calibrated and used as an indication of flow during flight tests. These tests indicated that we were getting a U of 4.1 in the

heat exchanger, which was approximately twice the amount of heat transfer that would be necessary during flight.

A 1/4-in. hydraulic fitting was inserted in the top of each cell, and a line was run from each of these fittings to the oxygen analyzing instrument to determine the oxygen content of the vapors in the tanks. Similar pickups were located at six points in the wing space outside of the tanks and connected to a manifold near the oxygen indicating instrument. This enabled us to take oxygen content samples every 30 sec. in each of the tanks and at six points in the space around the tanks during flight.

Complete instrumentation was placed on the heat exchanger, and the temperature of the nacelle and pressure drop through all of the lines were measured. It was found during flight tests that it was possible to inert the entire system during engine runup before take-off and to maintain this inert condition through all flight attitudes of this type airplane. At no time did the oxygen concentration exceed 62 per cent of the lower explosive limit. A carbon-monoxide indicator was located in the fuselage and operated continuously during all flight tests. At no time was there any indication of carbon monoxide in the inhabited areas of the airplane.

It is felt that this device should be of genuine value in eliminating many of the fire hazards in aircraft fuel tanks and in the spaces around these tanks. However, the greatest incidence of fire in aircraft during flight is found in the nacelle, and it is felt that it would be possible to close off the accessory section or zone 2 of the nacelle from outside ventilation and to install an inert gas system in this area. There is much work to be done alone these lines, but it is felt that it would be of great value.

Conclusions

(I) It is possible to maintain an inert tank under all flight conditions using the closed system.

(II) The equipment will have to be designed for each type of aircraft. The actual design will be dependent upon such conditions as rate of climb, and dive, physical layout of the fuel system, cooling air ducts, availability of exhaust gas, etc.

(III) It is thought likely that a successful exhaust gas system could be developed for each type of aircraft that employs gasoline for fuel and that this system can maintain an inert atmosphere in the tanks under all flight conditions.

(IV) The inherent advantages and disadvantages of the "open" and "closed" system are tabulated below on the assumption that the heat exchanger is designed for average demand and may be allowed to heat up slightly in a dive without detrimental effect.

(A) *Open System.*—(1) Advantages: (a) The elimination of a vacuum breaker and relief valve with subsequent inspection and maintenance of the latter. (2) Disadvantages: (a) Since the average demand and consumption of exhaust gas is greater with the "open" system than with the "closed," the heat exchanger should be of greater capacity, hence larger in size and of greater weight than that required for the "closed" system. (3) It was impossible to maintain an inert tank (less than 12 per cent oxygen content) at all times using the "open" system, particularly under diving conditions.

(B) *Closed System.*—(1) Advantages: (a) The equipment will be smaller in size and less in weight because of lessened demand. (b) It is possible to maintain an inert tank under all flight conditions. (2) Disadvantages: (a) Inspection and maintenance of the pressure relief and vacuum breaker valves will be needed. Good design should keep this to a minimum.

(C) *The weight* of a complete installation for a twin-engined aircraft similar to the R-5-C having fuel capacity of 1,440 gal. can be held under 25 lbs.

(D) *Corrosion.*—Corrosion studies of test specimens exposed to condensate showed deep pits in magnesium. Aluminum and a copper-base alloy showed slight attacks, while stainless steel showed no attack at all.

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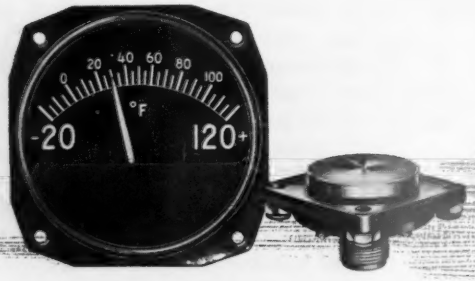

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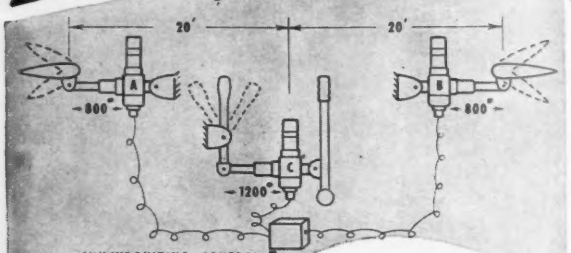

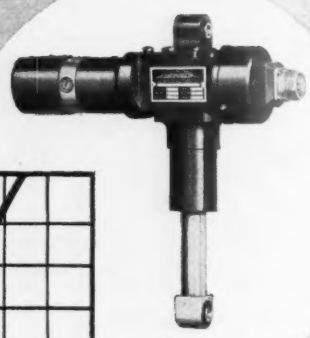

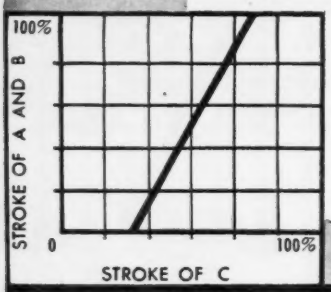

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Aerodynamics (2)

Aerodynamic Loads

Gust Load Coefficients for Wing and Tail Surfaces of an Aeroplane. H. J. Greidanus and A. I. van de Vooren. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. F.28,* April 12, 1948. 29 pp., figs., tables. 6 references. (In English.)

Extensive calculations of effect of gusts on wing and horizontal tail surfaces have shown that the static stability of the airplane exerts a marked influence on the tail loads. A numerical method of integration of the equations of motion was adopted instead of the operator methods used heretofore in order to retain more detail and thereby increase the accuracy of the solutions. The calculation of the gust-load coefficients takes into account the rotation of the aircraft about the lateral axis and the nonstationary aerodynamic forces that are established. The results are in good agreement with the earlier work. This report contains only a complete survey of all basic assumptions and discussion of the results. All detail calculations and the derivation of formulas have been omitted but will be collected and published in *Report No. F.29.*

BOUNDARY LAYER

Concerning the Effect of Compressibility on Laminar Boundary Layers and Their Separation. L. Howarth. *Royal Society of London, Proceedings, Series A,* Vol. 194, No. 1036, July 28, 1948, pp. 16–42, figs. 7 references.

The theory of compressible flow in a laminar boundary layer has been developed for the case when the viscosity is assumed to be proportional to the absolute temperature and the Prandtl number is unity. It is shown that a transformation of the ordinate normal to the layer can be lead to a simplified form of equation of motion similar to the ordinary incompressible equation but modified by a multiplicative factor G in the pressure term. This factor is greater than unity at the boundary and tends to one at the outside of the layer. Several particular solutions are considered including accelerated flow with a linearly increasing velocity and retarded flow along a flat plate with a linearly decreasing velocity. The general implications of the theory are discussed, and qualitative conclusions are drawn when the mainstream velocity starts from a stagnation point, rises to a maximum, and subsequently falls. For such a velocity distribution increasing compressibility will reduce the skin friction, increase the boundary-layer thickness, and cause earlier separaton as compared with the incompressible flow with the same mainstream velocity distribution and the kinematic viscosity corresponding to conditions at the stagnation point.

Boundary Layer Control. Brian Thwaites. *The Aeroplane,* Vol. 75, No. 1936, July 16, 1948, pp. 79–81, figs. A résumé of the theoretical and practical development of boundary-layer control.

The Boundary-Layer Flow Over a Permeable Surface Through Which Suction Is Applied. J. H. Preston. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2244,* February, 1946. 29 pp., figs. 9 references. British Information Services, New York, $1.75.

A brief review of existing work indicating the possibility of certain simple solutions for velocity distributions of the type $U = kx^m$ with their appropriate suction distributions. An improved approximate calculation is given for the "entry flow" along a flat plate through which constant suction is applied. Prandtl's original calculation, based on the momentum equation for the boundary-layer flow with constant suction and a constant adverse velocity gradient is repeated, using Howarth's accurate solution for flow without suction. Distributed suction is shown to be much more economical in quantity than suction flow through the minimum number of isolated slots required to prevent separation in the flow under a constant adverse velocity gradient. Porous suction should find application in stabilizing laminar flow against disturbances and in preventing separation. According to Pretsch, a suction velocity can be calculated which should make the boundary-layer flow past a flat plate stable against all small disturbances. The prevention of laminar separation coupled with the increase of stability makes possible a wing with 100 per cent laminar flow. Bluff shapes as extreme as a circular cylinder require only a comparatively small suction flow to overcome laminar separation. An extremely high maximum lift coefficient should be made possible even for an extremely thin wing by a surpris-

ingly small suction flow applied over less than 10 per cent of the chord. At present, porous bronze made by sintering metallic powder is the most suitable material for simulating in the laboratory the mathematical concept.

CONTROL SURFACES

Theoretical Characteristics in Supersonic Flow of Constant-Chord Partial-Span Control Surfaces of Rectangular Wings Having Finite Thickness. Warren A. Tucker and Robert L. Nelson. *U.S., N.A.C.A., Technical Note No. 1708*, September, 1948. 19 pp., figs. 10 references.

The Busemann third-order approximation for two-dimensional isentropic flow was used in suitable conjunction with three-dimensional solutions found by the linearized theory to determine analytically, for small angles of attack and control deflections, the control-surface characteristics of partial-span constant-chord flaps on rectangular wings having finite thickness. Equations were found for the lift coefficient, for the rolling-moment and hinge-moment coefficient due to control deflection, and for the pitching-moment coefficient due to flap lift. The effect of thickness is given by a single factor.

Approximate Relations for Hinge-Moment Parameters of Control Surfaces on Swept Wings at Low Mach Numbers. Thomas A. Toll and Leslie E. Schneiter. *U.S., N.A.C.A., Technical Note No. 1711*, October, 1948. 17 pp., figs. 9 references.

Contains derivations, based on an approximate theory, of equations for the hinge-moment parameters of control surfaces on swept wings at low Mach Numbers. Method accounts for effects of sweep and aspect ratio and considers, in an approximate manner, the effects of induced camber. Calculated and experimental values of the hinge-moment parameters are compared.

Flight Tests on the Longitudinal Behavior of the Vengeance IV with Special Reference to the Characteristics of the Spring Tab Elevator. J. Nivison. *Gt. Brit., Aeronautical Research Council, Reports and Memorandà No. 2268*, April, 1946. 24 pp., illus., diagrs., figs. 6 references.

The results show that the form of spring tab balance employed on the Vengeance IV elevator has enabled reasonably light stick forces to be achieved without introducing any penalizing adverse flying characteristics. The most interesting feature of the spring tab layout is the use of a subsidiary spring in conjunction with an aerodynamically unbalanced tab. By this means a stick force per g has been obtained which is virtually independent of speed.

Tail Loads During a Pull-Up From Horizontal Flight. IV—A Method for Computing Aircraft Tail Loads During a Pull-Up From Horizontal Flight for Any Given Elevator Motion. *Netherlands, National • Luchtvaartlaboratorium, Amsterdam, Rapport Nr. V.1438*, June 16, 1948. 18 pp., figs., tables. 9 references. (In English.)

This method of solving the equations of motion which express the relation between elevator motion and duration of the deflection may be used for any given relation between elevator deflection and time. The results obtained are in close agreement with those obtained with the other methods developed in this series of reports. The calculations are simple and can be performed on a slide rule. Between 4 and 5 hours were required to complete one typical case. If the tail loads are to be found for other values of flight parameters—e.g., air speed or altitude—the calculations must be repeated from the beginning.

FLUID MECHANICS & AERODYNAMIC THEORY

The Decay of Shock Waves. B. Cassen and J. Stanton. *Journal of Applied Physics*, Vol. 19, No. 9, September, 1948, pp. 803–807, figs.

The instantaneous rate of decay or intensification of a shock front in any fluid for which dissipative effects are localized in a shock zone is directly related to the coexisting pressure gradient in the wake of the wave adjacent to the front. The higher time derivatives of the shock velocity are also explicitly related, although in a more complicated fashion, to the higher spatial derivatives of wake pressure. Thus, the experimental observation of the velocity or some related variable of a blast or ballistic shock wave can be used to ascertain properties of the fluid motion in the wake of the shock. Conversely, a knowledge of the wake profile at any instant can be employed to determine the corresponding rate of decay of the shock front. The general theory is applicable to shocks of all strengths where an equation of state can be applied graphically or analytically.

Tables and Charts of Flow Parameters Across Oblique Shocks. Mary M. Neice. *U.S., N.A.C.A., Technical Note No. 1673*, August, 1948. 44 pp., figs., tables. 4 references.

The oblique shock-wave equations have been solved for the Mach Numbers in front of the shock from 1.05 to 4.0 and for shock angles ranging from a simple Mach wave to a normal shock. The tabulated results give the values of the Mach Number in front of the shock, the shock angle, the deviation of the flow across the shock, the Mach Number behind the shock, the ratio of pressure behind the shock to pressure in front of the shock, the ratio of density in front of the shock to density behind the shock, and the change in entropy across the shock. The variation of angle of shock with Mach Number in front of the shock for various deviations of the flow, variation of the Mach Number behind the shock with Mach Number in front of the shock for various deviations of the flow, and variation of maximum deviation of flow across the shock with Mach Number in front of the shock have been plotted as curves.

Singularities at the Sonic Velocity (Project No. HA-219). K. Gottfried Guderley. *U.S., Air Force, Technical Report No. F-TR-1171-ND(GS-USAF Wright-Patterson Air Force Base No. 75) (ATI No. 23965)*, June, 1948. 118 pp., figs. 16 references.

A method that was developed in an attempt to extend Busemann's work on conical flows to the neighborhood of sonic velocity employs the hodograph to represent singularities that occur at sonic velocity. By using transonic laws of similarity, linear hypergeometric differential equations are obtained. The partial differential equation that can be solved exactly for the singularities by this method is fulfilled by particular solutions formed with Langer's asymptotic representations of the hypergeometric functions. Since the method is applicable to the subsonic range, it can be used when the sonic velocity is being approached. The hodograph map of a body in parallel flow has a singularity at the point that corresponds to the velocity at infinity; hence, in a flow with a free-stream Mach Number of 1, a singularity at sonic velocity in the physical plane will arise. Therefore, the method is used to study the reflections of singularities at the sonic line, the flow over a corner, the flow through a Laval nozzle, and the flow past a body at the free-stream Mach Number 1.

Notes on a Family of Rotational Gas Flows. R. C. Prim. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 319–325, figs. 3 references.

A formally simple infinite family of truly rotational flow solutions—i.e., flows that have rotational velocity fields and rotational reduced velocity fields. The family includes the irrotational Prandtl-Meyer corner flow as a special case.

A Method for the Calculation of External Lift, Moment, and Pressure Drag of Slender Open-Nose Bodies of Revolution at Supersonic Speeds. Clinton E. Brown and Hermon M. Parker. *U.S., N.A.C.A., Report No. 808*, 1945. 8 pp., diagrs., figs. 7 references. U.S. Govt. Printing Office, Washington. $0.15.

Decay of Isotropic Turbulence in the Initial Period. G. K. Batchelor and A. A. Townsend. *Royal Society of London, Proceedings, Series A*, Vol. 193, No. 1035, July 21, 1948, pp. 539–558, figs. 9 references.

Wind-tunnel measurements of turbulence intensity and frequency show that the reciprocal of the mean square turbulence intensity and the frequency squared are directly proportional to the time of decay if the time is not too great. During the initial period of turbulence the double and triple velocity correlation functions are self-preserving when the correlations are taken at small intervals. At larger intervals the double velocity correlation function changes its form slightly during decay. The frequency of the turbulence increases in direct proportion to the interval. This decay law changes when the time is large in the direction predicted by the theory that postulates the eventual replacement of this decay law by a new decay law. Some of the measurements confirm the existence of an initial and a final stage in the life history of turbulence, bridged by a transitional period. A correlation of the measurements with Reynolds Number confirm the significance of Reynolds Number as an index to the type of turbulence occurring throughout the initial period. Three roughly separate régimes can be distinguished, each of which depends on the magnitude of the Reynolds Number and has its own body of theory.

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Diabatic Flow of a Compressible Fluid. Bruce L. Hicks. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 221–237, fig. 18 references.

The principal characteristics of steady diabatic compressible flow. The treatment is applicable to both thin and thick burning regions and to both subsonic and supersonic flow conditions met with in combustion aerodynamics if algebraic equations are added whenever necessary to express conservation of energy, mass, and momentum across flow discontinuities. Three representations have been studied of fields of flow of an inviscid compressible fluid that contain distributed heat sources. That afforded by the vector $\boldsymbol{WV}/=V_i$, where $\boldsymbol{V}$ is the velocity vector and V_i is the (variable) limiting velocity, appears to be the most convenient for rotational flows. Thus, the intimate connection between vorticity $\omega \mid \nabla = \times \boldsymbol{W} \mid$ and the heating factor $q=Q/V_i^2$ (Q is the energy added per unit time and mass) is shown in $\boldsymbol{W}$ language by the equation for uniplanar flow, which contains terms denoting spatial differentiation parallel and perpendicular to streamlines and the (static) fluid pressure. The concept of irrotational flow has been broadened to include diabatic flow fields in which $\boldsymbol{V}$, $\boldsymbol{W}$, or $\boldsymbol{M}=\boldsymbol{V}/a$ (a is a local velocity of sound) is irrotational. Although the character of the corresponding heat source distributions is decidedly different in the three types of irrotational flow, the partial differential equations for the potential functions φ_v, ϕW, and ϕM are all quasilinear and, except in the case of φ_v, each contains an arbitrary function of the potential function, which is a consequence of the diabatic nature of the flow.

Heat Transfer From a Rotating Disk to Ambient Air. Carl Wagner. *Journal of Applied Physics*, Vol. 19, No. 9, September, 1948, pp. 837–839. 2 references. The coefficient of heat transfer from a rotating disc to ambient air in case of a laminar boundary layer is theoretically calculated on the basis of von Kármán's calculation of flow conditions.

The Lost Solutions in Axially Symmetric Irrotational Compressible Fluid Flow. H. J. Stewart. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 334–337. 3 references.

A Primer of Sonic Aerodynamics. Robert McLarren. *Aviation Week*, Vol. 49, No. 7, August 16, 1948, pp. 21, 22, 24, 26, figs.

The mechanics of the formation of shock waves and expansion waves on airfoils at transonic and supersonic speeds and their effect on the lift coefficient of airfoils; the effect of using thin wings, low aspect-ratio wings, swept and delta wings, and unorthodox profile shapes to delay the formation of shocks; a summary of the limitations of wind-tunnel research in compressible flow; and research techniques that have been used in the study of transonic flow.

Compressible Potential Flow with Circulation About a Circular Cylinder. Max A. Heaslet. *U.S., N.A.C.A., Report No. 780*, 1944. 9 pp., figs. 14 references. U.S. Govt. Printing Office, Washington. $0.15.

Propagation of a Two-Dimensional Irrotational Supersonic Flow Along a Wall. (*Dresden, Technische Hochschule, Peenemünde Archiv No. 44/9*, November 5, 1942.) *Brown University, Graduate Division of Applied Mathematics, Translation No. A9-T-10 (Advance Copy)*, 1948. 13 pp., figs.

The development of a detailed, quantitatively accurate expression for the propagation of irrotational supersonic flow along a concave or convex boundary. Two independent methods of solution are used: one employing the hodograph method; the other, the basic equations for plane potential flow. The agreement of the two results attests their correctness. The sign of the expression and the case of convergence of Mach waves of the same family are treated.

A Kinetic Theory of Turbulence. Gwoh-Fan Djang. *Chinese Journal of Physics*, Vol. 7, No. 3, June, 1948, pp. 176–191, fig.

Because of the similarity between the turbulence of fluid motion and the random flight of gas molecules, the statistical methods that have been used to study this behavior of gas are used to study turbulence. State functions similar to those used with gases are defined for turbulence "temperature," "pressure," and "entropy," and these functions of temperature and pressure are incorporated in the equations of turbulent motion. The application of this method to the flow through a uniform circular pipe shows that the velocity fluctation varies inversely with the distance from the wall. The theoretical velocity distribution obtained for flow between parallel planes agrees well with the experimentally determined distribution. An analysis of the structure of turbulence shows that the frequency distribution agrees with that which Dryden has found to hold true. The expression for the size of turbulence is of the same form as a first approximation of the correlation function given by the statistical theory developed by Taylor.

The Laminar Boundary-Layer Equations of Bodies of Revolution; Motion of a Sphere. D. Meksyn. *Royal Society of London, Proceedings, Series A*, Vol. 194, No. 1037, August 12, 1948, pp. 218–228, figs. 8 references.

The general equations of motion are derived for the boundary layer of axially symmetric bodies of rotation. For the front part of a sphere these are found to be identical with the equation for the case of a cylindrical body. The evaluated surface friction for the front part of a sphere agrees with the computations and measurements of Fage. The pressure consists of two parts. One is equal to the inviscid pressure, the other depends on the thickness of the boundary layer.

A General Kinetic Theory of Liquids. V—Liquid He II. H. S. Green. *Royal Society of London, Proceedings, Series A*, Vol. 194, No. 1037, August 12, 1948, pp. 244–258, figs. 18 references.

INTERNAL FLOW

Effect of Screens in Wide-Angle Diffusers. G. B. Schubauer and W. G. Spangenberg. *U.S., N.A.C.A., Technical Note No. 1610*, July, 1948. 59 pp., diagrs., figs. 5 references.

When a screen or similar resistance is placed across a diffuser there is a spreading effect on the low-speed stream that flows through the screen when the stream is unbounded or is bounded by a region of low velocity. The spreading action depends on the initial velocity distribution, on conditions at the stream boundaries, and on the pressure-drop coefficient of the stream. The mechanics by which the screen can prevent separation or restore separated flow is intimately connected with the mechanics of turbulent boundary-layer separation. The screen may act by increasing the normal velocity gradient along the wall or by a combination of the two effects. Separation may be prevented and a filled condition obtained throughout a properly shaped diffuser by a single screen or throughout a diffuser of arbitrary shape by using a sufficient number of appropriate screens properly spaced. A filled condition and uniform velocity distribution may be attained downstream from a single screen in a diffuser of arbitrary shape even in the presence of separated flow upstream from the screen. The stabilizing effects of such screens greatly diminish the speed fluctations normally resulting from such separation. Diffuser efficiency is generally low when the prevention of separation depends on the action of one or more screens. The principal losses result from the pressure drop through the screens. Wide-angle diffusers with damping screens have found application in wind tunnels.

The Relative Merits of Rotary Compressors. D. G. Samaras and R. A. Tyler. *Journal of the Aeronautical Sciences*, Vol. 15, No. 10, October, 1948, pp. 625–631, figs. 19 references.

The principle of similarity is developed to obtain expressions for the flow coefficient, the pressure coefficient, and the small stage efficiency of rotary pumps. An examination of such reliable experimental data as is available for centrifugal and axial-flow compressors, Roots and Lysholm blowers, angular compressors, and propellers shows every type of rotary compressor to be characterized by a distinct, relatively narrow band of load factor and, for each type, by a particular load for which the efficiency is intimately linked with the nature of the particular type of compressor and increases from one type to another as the characteristic load factor decreases. The axial-flow compressor appears to be at present about 10 per cent more efficient than the centrifugal compressor.

Experimental Study of Effect of Vaneless-Diffuser Diameter on Diffuser Performance. Guy R. Bradshaw and Eugene B. Laskin. *U.S., N.A.C.A., Technical Note No. 1713*, October, 1948. 28 pp., illus., diagrs., figs. 4 references.

The variations in compressor and diffuser efficiency with diffuser diameter were studied on four vaneless diffusers of different diameter. Overall efficiency increased with diffuser diameter. In all the diffusers, losses in efficiency were limited to the entrance and exit regions, losses in the interior of the diffuser being negligible.

Measurements on Compressor-Blade Lattices. F. Weinig and B. Eckert. (*Luftfahrtforschungsanstalt Hermann Göring, Institut für Motorenforschung, Bericht der Gittertagung*, March 27, 28, 1944.) *U.S., N.A.C.A., Technical Memorandum No. 1193*, August, 1948. 9 pp., illus., diagrs., figs.

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PARASITIC COMPONENTS & INTERFERENCE

Air Resistance of a Flat Plate of Very Porous Material. G. I. Taylor. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2236*, January, 1944. 4 pp., figs. British Information Services, New York. $0.35.

Pressure Distribution Measurements on Jet Nacelles. F. Riegels and H. Eggert. (*Göttingen, Aerodynamische Versuchsanstalt, ZWB/A VAG/44/A/39*, December 29, 1944.) *U.S., Air Force, Translation No. F-TS-3154-RE (ATI No. 23187)*, July, 1948. 26 pp., diagrs., figs.

Pressure distribution measurements were made on the after portion of variously shaped nacelles for jet engines in order to determine the influence of nacelle design on the pressure drop at the jet exhaust. This pressure differential was found to be primarily a function of the ratio of the airflow velocity to the jet-exhaust velocity and to be increased only slightly by flow separation on the tail section. Separation occurred when the tail cone angle exceeded 35°.

PERFORMANCE

Comparative Effects of Small Changes in Profile Drag and Weight on Aircraft Performance. A. L. Courtney. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2260*, February, 1946. 11 pp., tables. British Information Services, New York. $0.90.

Expressions are derived which give the number of pound change in weight that has the same effect as 1 lb. at 100 ft. per sec. change in profile drag, for the more important characteristics. Three classes of aircraft are considered—namely, (a) those already built or of fixed design; (b) those in the early design stage when wing area can be varied to keep wing loading constant; (c) project designs for which all characteristics can be assumed continuously variable. For the latter class the effects of all-up weight to meet a given specification are considered. The note covers propeller-driven fighters and transports, including propeller-turbine transports and jet aircraft in general. Except where otherwise stated the results obtained for propeller-driven aircraft are applicable to both piston and turbine engines. Compressibility effects are not considered.

STABILITY & CONTROL

Flight Measurements of the Longitudinal Stability, Stalling, and Lift Characteristics of an Airplane Having a 35° Sweptback Wing Without Slots and with 40-Per Cent-Span Slots and a Comparison with Wind-Tunnel Data. S. A. Sjoberg and J. P. Reeder. *U.S., N.A.C.A., Technical Note No. 1679*, August, 1948. 53 pp., illus., diagr., figs. 1 reference.

An investigation of the low-speed flying qualities of single-engined monoplane. Longitudinal stability, with or without slots, was high with flaps up. With flaps down, it was high at moderate speeds but became neutral or slightly negative near the stall. Slots increased the stalling speed and therefore reduced the range of the neutral or negative stability. Without slots there was an uncontrollable rolling and pitching motion with flaps up, and the airplane reached extreme attitudes after the stall. With flaps down the airplane without slots rolled and settled abruptly at the stall. Stalling characteristics of the airplane with 40 per cent span slots were good. The flight values of maximum normal-force coefficient were, in most cases, higher than the wind-tunnel values. Deflecting the flaps of wings without slots increased the maximum normal-force coefficient approximately 0.3 in flight and 0.07 in the wind tunnel. For the wing with slots the increase was approximately 0.2 in flight and 0.04 in the tunnel. The coefficient of the slotted wings was considerably lower than that for the wing without slots. This difference is attributed to the separation of the airflow on the wing which was observed just inboard of the slot.

Appreciation and Prediction of Flying Qualities. William H. Phillips. *U.S., N.A.C.A., Technical Note No. 1670*, August, 1948. 128 pp., diagrs., figs. 41 references.

A summary of the results of flight tests, wind-tunnel measurements, and theoretical investigations on the stability and control characteristics of an airplane which are important from the pilot's standpoint. The discussion shows the effect of design on longitudinal stability and control in straight and accelerated flight, directional stability and control, aileron control characteristics, stalling characteristics, and control-free stability or short-period oscillations. The section on wind-tunnel testing includes the simulation of power conditions, testing for landing and take-off qualities, and the determination of neutral points. The material is intended to aid designers in selecting or modifying a configuration that will provide satisfactory stability and control characteristics.

Flight Handling Characteristics of a Modern Transport Airplane. Scott Flower, Melvil Gough, Raymond B. Maloy, and G. S. Trimble, Jr. *Aeronautical Engineering Review*, Vol. 7, No. 10, October, 1948, pp. 18–31, figs.

The text of four papers presented at the symposium: suggestions for flight-control and handling characteristics to supplement those laid down in the Civil Air Regulations Part 04 which would increase pilot acceptance, by Scott Flower; the development of a systematic technique for the collection, analysis and application of data on fundamental flight and handling characteristics, with references to available literature, by Melvin Gough; a discussion of the controllability, trim control, stability, and stalling requirements contained in CAR 04b. 13, by Raymond B. Maloy; and the effect of safety and handling requirements on the design of an airplane, by G. S. Trimble, Jr.

Comparison of Wind-Tunnel and Flight Measurements of Stability and Control Characteristics of a Douglas A-26 Airplane. Gerald G. Kayten and Willian Koven. *U.S., N.A.C.A., Report No. 816*, 1945. 14 pp., diagrs., figs. 4 references. U.S. Govt. Printing Office, Washington. $0.15.

Lateral Stability and Control Characteristics of a Free-Flying Model Having an Unswept Wing with an Aspect Ratio of 2. Marion O. McKinney, Jr., and Robert E. Shanks. *U.S., N.A.C.A., Technical Note No. 1658*, July, 1948. 30 pp., figs. 4 references.

Wind-tunnel test data for a free-flying model aircraft having an upswept wing with an aspect ratio of 2, upon comparison with data for a conventional model with an aspect ratio of 6, showed that the general flight behavior of the low-aspect-ratio model was not as good as that of the conventional model with respect to static directional stability and effective dihedral. The primary cause of the difference in flight behavior of the models was the adverse yawing moments due to aileron deflection, which, as predicted by theory, was considerably larger for the low-aspect-ratio model.

WINGS & AIRFOILS

A New Treatment of the Lifting-Line Wing Theory, with Applications to Rigid and Elastic Wings. W. R. Sears. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948. pp. 239–255, figs. 14 references.

The Prandtl lift-line theory is formulated in terms of integral equation of the classical type and a practical solution is carried out in terms of eigenfunctions of the integral equation. This recourse to the underlying mathematical character of the problem leads to certain essential simplifications, since the eigenfunctions and eigenvalues are characteristic of a family of plan forms and do not depend on the angle-of-attack distribution. The solution of the lifting-line problem is found immediately in the form of a series expansion in eigenfunctions for which the coefficients may be calculated if the eigenvalues and functions are known for the plan form under consideration. The numerical method of calculation is that used in vibration problems, and all the numerical data required to use the method with trapezoidal plan forms with taper ratios from 1 to 4 are tabulated. For rigid wings the use of eigenfunctions reduces every lift-distribution calculation to the same simplicity that ordinarily occurs only for the elliptical plan form. However, since the eigenfunctions are not conveniently tabulated and are not so simple as trigonometric functions, this simplification of lift-distribution calculation is partly illusory, and for practical use one actually works with the Fourier constants. Nevertheless, the span loading is calculated by a straightforward process that requires only the Fourier coefficients of the angle-of-attack function besides tabulated quantities and no procedure of successive approximations. In the application of this method to the elastic wing, the integral equation is put into matrix, and matrix techniques are used for numerical solution. In making this formulation, use has been made of the knowledge of a complete set of functions, the eigenfunctions of the plan form,

for which the Prandtl functional can be written down immediately.

Supersonic Wave Drag of Nonlifting Sweptback Tapered Wings with Mach Lines Behind the Line of Maximum Thickness. Kenneth Margolis. *U.S., N.A.C.A., Technical Note No. 1672,* August, 1948. 34 pp., figs. 3 references.

The theoretical investigation of supersonic wave drag of sweptback tapered wings at zero lift with thin symmetrical double-wedge sections with maximum thickness at 50 per cent chord is extended to include the case in which the flight velocity component normal to the line of maximum thickness is supersonic. The drag coefficient is decreased in the near-sonic and moderately supersonic range and is affected negligibly at high supersonic speeds when the taper is increased and the aspect ratio and sweepback are constant. For given sweep and taper ratio, higher aspect ratios increase the drag coefficient in the intermediate range and have negligible effect when the maximum-thickness line is highly supersonic. Like effects are observed for variations in taper of wings with equal root bending stresses and given sweepback. Increased sweepback for given taper ratio and aspect ratio increases the drag coefficient when the maximum-thickness line is supersonic.

Graphical Method of Obtaining Theoretical Lift Distributions on Thin Wings at Supersonic Speeds. Clarence B. Cohen and John C. Evvard. *U.S., N.A.C.A., Technical Note No. 1676,* August, 1948. 42 pp., figs. 2 references.

The method, which is based on linearized supersonic-flow theory, is applicable to all of the regions of arbitrary wings except those affected by interacting flow fields off the wing-plan boundaries. The determination of the lifting-pressure coefficient for a given point has been found to require from 5 to 10 min. The resultant average error determined by comparison with known analytical solutions was less than 1 per cent. The method is illustrated for a wing of circular plan form and for a straight wing with a circular tip at Mach equals 2.

Influence of Leading-Edge Suction on Lift-Drag Ratios of Wings at Supersonic Speeds. Clarence B. Cohen. *U.S., N.A.C.A., Technical Note No. 1718,* October, 1948. 27 pp., figs. 3 references.

A method for calculating theoretical linearized suction force at subsonic leading edges of family of wings at supersonic speeds. Optimum sweepback angles for tips of trapezoidal wings are determined, including effects of friction. The possible gain in lift-drag ratio for region of wing affected by tip increases as the sweepback of wing is increased. An appropriately curved tip gives higher lift-drag ratios than the best trapezoidal tip.

An Evaluation of the Characteristics of a 10-Percent-Thick NACA 66-Series Airfoil Section with a Special Mean-Camber Line Designed to Produce a High Critical Mach Number. Laurence K. Loftin, Jr., and Kenneth S. Cohen. *U.S., N.A.C.A., Technical Note No. 1633,* July, 1948. 33 pp., figs. 5 references.

The mean-camber line of an airfoil may be so designed that the induced velocities resulting from the camber will occur over that part of the airfoil chord along which the induced velocities resulting from the basic thickness are small. In order to make data on such an airfoil available, high-speed and low-speed measurements were made on the NACA 66_m-210 ($a = 1.0$, $C_{l_i} = 0.6$; and $a = 0.6$, $C_{l_i} = -0.4$) and the NACA 66-210, a 1.0 airfoil sections. The airfoil with the special camber had a drag-divergence Mach Number at the design lift coefficient slightly higher than that of the NACA 66-210, $a = 1.0$, but this increase was not so great as that shown by calculations based on low-speed data of of the critical Mach Numbers for the two airfoils. With the exception of a negative increase of about 50 per cent in the pitching moment, the low-speed characteristics of the special section were essentially the same as those of the airfoil section cambered with the conventional mean line.

The Estimation of Wing Divergence Speeds. E. G. Broadbent. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2288,* December, 1945. 10 pp., figs. 14 references. British Information Services, New York. $0.70.

A simple and rapid method of calculating the divergence speed of an elastic wing. The method is also adapted to give an approximate solution for the aileron reversal speed. The severity of these two phenomena may be compared with that of flexure-torsion flutter on the basis of the simple flutter criterion.

Investigation at Low Speeds of the Effect of Aspect Ratio and Sweep on Static and Yawing Stability Derivatives of Untapered Wings. Alex Goodman and Jack D. Brewer. *U.S., N.A.C.A., Technical Note No. 1669,* August, 1948. 34 pp., illus., figs. 8 references.

The rolling-flow and curved flow principle of the Langley stability tunnel has been used to determine experimentally the effects of independent variations of the aspect ratio and the sweep angle on the static and yawing stability characteristics of a series of untapered wings. The effect of sweep on the lift-curve slope, drag, the effective-dihedral parameter, and the static stability characteristics generally became smaller as the aspect ratio decreased. For constant sweep angle, the magnitude of the damping in yaw decreased. For constant sweep angle, the magnitude of the damping in yaw decreased with an increase in aspect ratio for the low lift-coefficient range. At some moderate lift coefficient, this derivative, upon changing sign, became positive for the 45° and 60° swept wings. For unswept wings, the rolling moment due to yawing was nearly proportional to the lift coefficient until maximum lift was attained. For sweptback wings, linear variations of rolling moment due to yawing were obtained over only a limited lift range. At high lift coefficients, the values of the rolling moment due to yawing decreased, becoming negative in some instances near maximum lift. The rate of change of rolling moment due to yawing with lift coefficient usually increased with both sweep and aspect ratio for the low lift-coefficient range. At low and moderate lift coefficients, the experimental data agreed in general with a simple sweep theory.

Divergence of Swept Wings. Franklin W. Diederich and Bernard Budiansky. *U.S., N.A.C.A., Technical Note No. 1680,* August, 1948. 32 pp., figs. 7 references.

A theoretical analysis of the divergence speed of tapered and untapered swept wings which takes into account the effect of elastic bending and twisting along the wing span. Curves of nondimensional parameters from which the divergence speed can be estimated for a given design are plotted for swept wings with constant chord and constant flexural and torsional stiffness along the span and for swept wings with linearly varying chords with flexural and torsional stiffness varying quartically with the chord. The divergence speed drops rapidly as sweep-forward increases up to about 40°. Wings with sweepback beyond a fairly low value cannot diverge. Moving the elastic axis forward raises the divergence speed appreciably for low angles of sweep but has less effect at higher sweep angles. Wings with the elastic axis forward of the aerodynamic center can diverge only for moderate or large angles of sweep-forward. Conventional taper increases the divergence speed of essentially unswept wings and decreases the divergence-speed of wings with moderate and large angles of sweep if the stiffness varies with the fourth power of the chord. A limited number of low-speed wind-tunnel tests on untapered models gave good agreement with the theoretical results for angles of sweep-forward up to 40°.

A Linearized Solution for Time-Dependent Velocity Potentials near Three-Dimensional Wings at Supersonic Speeds. John C. Evvard. *U.S., N.A.C.A., Technical Note No. 1699,* September, 1948. 35 pp., figs. 30 references.

A source-distribution method is applied to derive a solution for the time-dependent linearized perturbation-velocity potential of three-dimensional wings at supersonic speeds. The solution is illustrated by evaluating the upwash over the tip of an arbitrary plan-boundary wing having a supersonic and subsonic leading edge. The upwash then gives the effective sources of the flow field lying between the wing plan boundary and the foremost Mach waves so that the velocity potential may be evaluated.

Characteristics of Low-Aspect-Ratio Wings at Supercritical Mach Numbers. John Stack and W. F. Lindsey. *U.S., N.A.C.A., Technical Note No. 1665,* August, 1948. 26 pp., illus., figs. 7 references.

Wind-tunnel tests of wings of aspect ratios ranging from infinity to 2 at supercritical Mach Numbers ranging above $M = 0.9$ showed that the detrimental effects of compressibility in the supercritical speed range on the stability and performance of aircraft can be alleviated by the use of low-aspect-ratio lifting surfaces.

The Design of Minimum Drag Inboard Fins. V. M. Falkner. **Appendix: On the Conformal Transformation of a Wing with Symmetrical Inboard Fins.** Charles Darwin. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2280,* October, 1945. 15 pp., figs., tables. 1 reference. British Information Services, New York. $1.00.

The theory and some examples of the design of inboard minimum drag fins by the lifting-line theory. The circulation distribution for a range of single and symmetrical fins have been calculated, and the solutions have been tabulated to permit the shape and setting of wing, fin, and wing extension and their lift and drag characteristics to be determined. The illustrative examples indicate that a properly designed wing, with inboard fin or fins of moderate height in the middle region of the semispan, has lift and induced-drag characteristics that do not differ greatly from the optimum obtainable for the same aspect ratio without a fin. If a moderate fixed inboard fin were used for sideflow control, the penalty, apart from interference effects, would be somewhat less than the additional profile drag. The calculated effect on the wing loading of a retractable fin shows that the loading is localized mainly near the fin junction. The loading near the tip is unaltered, but there is a marked decrease of load immediately outside the fin which might be of importance in connection with stalling if the fin position coincided with the peak local lift coefficient. The effect of the load alteration on rolling moment is small.

The Numerical Evaluation of the Poisson Integral. R. Timman. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. F.32,* June 16, 1948. 25 pp., figs., tables. 8 references. (In English.)

A matrix method for the numerical computation of the Poisson integral in the derivation of the conjugate function of a given function that is expressed as a Fourier series. In order to avoid the inaccurate results that are obtained with the matrices developed by Riegels-Wittich, Germain, and Watson, the new matrices are based on a polynomial approximation of the original function. This avoids the waviness introduced into the conjugate function by Gibbs phenomenon when the given function has a locally steep gradient somewhere within the interval. By using Schoenberg's series of interpolation formulas for the approximation of equidistant data, instead of the Lagrange polynomials ordinarily used for interpolation, an interpolation function is obtained which is continuous and has continuous first derivatives everywhere in the range of the variable.

The Design of Minimum Drag Tip Fins. V. M. Falkner. **Appendix: On the Conformal Transformation of a Wing with a Fin.** Sir Charles Darwin. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2279,* March, 1945. 15 pp., figs. 7 references. British Information Services, New York. $0.90.

An investigation into the design of minimum drag tip fins by lifting line theory. The work is based on an exact solution of the conformal transformation that is applicable to this problem following the method of Trefftz. Three types of solution are treated corresponding to symmetrical upper and lower fins, single upper or lower fins, and unequal upper and lower fins. A representative range of solutions for circulation distribution along wing and fins has been calculated for each of the three cases by the use of elliptic and theta functions. A detailed account is given, with examples, of the procedure for calculating the plan of wing and fins, the lift and induced drag, and the setting of the fins.

Investigation of Effects of Geometric Dihedral on Low-Speed Static Stability and Yawing Characteristics of an Untapered 45° Sweptback-Wing Model of Aspect Ratio 2.61. M. J. Queijo and Byron M. Jaquet. *U.S., N.A.C.A., Technical Note No. 1668,* September, 1948. 29 pp., figs. 6 references.

An increase in positive dihedral resulted in an increase in the rolling moment due to sideslip and also caused the maximum value of rolling moment due to sideslip to occur at increasingly higher lift coefficients. Increasing positive or negative dihedral caused a decrease in the lift curve slope and an increase in the variation of lateral force with sideslip. Dihedral had no appreciable effect on the yawing moment due to sideslip.

Load Distributions Due to Steady Roll and Pitch for Thin Wings at Supersonic Speeds. W. E. Moeckel and J. C. Evvard. *U.S., N.A.C.A., Technical Note No. 1689,* August, 1948. 28 pp., figs. 5 references.

A method for determining the load distribution due to steady roll and pitch for thin flat-plate wings whose plan form is arbitrary except that a part of the leading edge must be supersonic. For wings with straight supersonic leading edge, the load distributions due to angle of attack, steady roll, and steady pitch are explicitly evaluated and are computed for a family of wings whose plan form includes most types of flow region commonly encountered. The negative lift existed toward the rear of pointed wings whose aspect ratio was small. In steady roll, negative loading occurred in regions influenced by the edge of the plan form at the opposite side of the roll axis. When the pitch axis was located near the semichord position, the load gradient for steady pitch was approximately in the chordwise direction, except in regions influenced by subsonic trailing edges. High positive loading occurred toward the front of the wing and high negative loading toward the rear.

Linearized Supersonic Theory of Conical Wings. P. A. Lagerstrom. (*California Institute of Technology, Jet Propulsion Laboratory, Progress Report No. 4-36.*) *U.S., N.A.C.A., Technical Note No. 1685,* August, 1948. 161 pp. diagrs., figs. 20 references.

A development and clarification of the Busemann theory of conical wings, which treats in detail the general methods and the basic conical solutions. Boundary conditions and general methods such as the oblique transformation are discussed in detail to provide background from which expressions for the entire flow field may be derived. The given wing of finite chord and span is divided into various regions in each of which some conical solution is valid. The effect of angle of attack is separated from the effect of thickness by the use of the superposition principle. From these basic solutions the flow field near the wings of simple plan forms and profile is determined. By using wings of constant-lift distribution the method is extended to determine the downwash and sidewash behind a three-dimensional wing. The solutions that are obtained for interference problems make it possible to solve the flow for a wing consisting of a region of constant lift adjacent to a flat plate. This type of solution includes the low aspect-ratio wing. The case of adjacent flat regions at different angles of attack has been applied to control surfaces.

Pressure Distribution and Wake Traverses on Models of Mustang Wing Section in the Royal Aircraft Establishment and National Physical Laboratory High Speed Tunnels. J. S. Thompson, M. Markowicz, J. A. Beavan, and R. G. Fowler. **Addendum: Pressure Distribution on a Two-Dimensional Mustang Wing Model in the Royal Aircraft Establishment 7-ft. Tunnel.** J. S. Thompson and W. Port. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2251,* August, 1944. 47 pp., figs. 10 references. British Information Services, New York. $2.65.

Readings were taken over an incidence range of about 4° up to the maximum speed of each tunnel. The general variations of C_p along the chord and of C_L, C_D, and C_M with M agree in the two tunnels, but there is a divergence of absolute values. At low speeds the R.A.E. values of C_p are from 0.05 to 0.10 more negative, the lift curve slope is 10 per cent greater, and the drag is 40 per cent higher. The discrepancy in drag is attributed to a rougher model surface and greater tunnel turbulence in the R.A.E. tunnel, giving transition at 0.3c instead of 0.6c in the N.P.L., at high speeds the values of M at which critical charges occur are lower in the R. A. E. tunnel than in the N. P. L., the differences in M being up to 0.04. The airfoil characteristics are in accordance with its design as a low-drag section, having a C_D = 0.006 to 0.007 (at $R = 1.5 \times 10^6$) prior to a steep shock rise starting at about $M = 0.7$. Lift and pitching moment, up to the shock stall, show rises greater than predicted by the Glauert formula.

The Lift of a Body-Wing Combination. Sighard F. Hoerner. *U.S., Air Force, Technical Report No. F-TR-1187-ND(GS-USAF Wright-Patterson Air Force Base No. 103) (ATI No. 27206),* September, 1948. 11 pp., figs. 20 references.

A general, approximate calculation of a body-wing combination appropriate for a subsonic or supersonic airplane missile. Both the body and the wing contribute to the total lift, but, when they are combined, the lift contributed by the wing depends on its exposed area, its effective aspect ratio, and the upwash angle at the wing root. With rectangular and all other wings with aspect ratios less than 1 or 2, the total lift decreased as the ratio increased. The total lift is also determined to some extent by the longitudinal position of the wing relative to the body. Generally, the interference between a body and a wing remains the same in both incompressible and in supersonic flow.

Aerodynamic Characteristics of 24 NACA 16-Series Airfoils at Mach Numbers Between 0.3 and 0.8. W. F. Lindsey, D. B. Stevenson, and Bernard N. Daley. *U.S., N.A.C.A., Technical Note No. 1546,* September, 1948. 86 pp., figs. 8 references.

A compilation of basic data showing the variation in aerodynamic characteristics with Mach Numbers at constant angles of attack for each of the NACA 16-series airfoils. Cross-plotted

data show the effects of variation of thickness-chord ratio and camber or design lift coefficient on aerodynamic characteristics. The plots show the effect of camber on the variation of lift-drag ratio with lift coefficient for airfoils of 6 per cent, 9 per cent, and 15 per cent; the effect of thickness on lift-drag ratio for cambered airfoil having a design lift coefficient of 0.3; the maximum negative pressure coefficients derived theoretically for NACA 16-series airfoils; the maximum negative pressure coefficients in an incompressible or low-speed flow transcribed to critical Mach Numbers by von Kármán-Tsien's relation; a comparison between the theoretically derived and the experimentally determined critical Mach Numbers; the critical Mach Numbers measured at several stations on an untwisted propeller tip compared with the values estimated from two-dimensional flow; a comparison between the critical Mach Number and the Mach Number for lift break and maximum lift-drag ratio; and the effect of thickness and camber on the Mach Numbers for lift break and drag rise. Between Mach Numbers 0.3 and 0.8 the ratio of the lift coefficient to the design lift coefficient was generally less than unity and varied with the airfoil thickness-chord ratio. The theoretical method of estimating the critical Mach Number provided values in reasonably good agreement with experiment. The design camber resulting in best lift-drag ratio for a given lift coefficient decreased abruptly as the force-break Mach Number was approached and exceeded. The adverse changes in angle of attack required to maintain a fixed lift coefficient decreased as the design camber was reduced.

Experimental and Calculated Characteristics of Several High-Aspect-Ratio Tapered Wings Incorporating NACA 44-Series, and Low-Drag 64-Series Airfoil Sections. Thomas V. Bollech. *U.S., N.A.C.A., Technical Note No. 1677*, September, 1948. 37 pp., illus., figs. 6 references.

The Rolling Moment Due to Sideslip of Triangular, Trapezoidal, and Related Plan Forms in Supersonic Flow. Arthur L. Jones, John R. Spreiter, and Alberta Alksne. *U.S., N.A.C.A., Technical Note No. 1700*, September, 1948. 60 pp., figs. 9 references.

The variation of rolling-moment coefficient with sideslip was found to be approximately linear over a small range of sideslip angles. Both positive and negative dihedral effects were obtained. For a given plan-form type and a given tip or leading-edge classification (subsonic or supersonic), derivatives evaluated for the linear range of the variation of the rolling-moment coefficient with the sideslip angle were found generally to decrease in magnitude with increasing aspect ratio. This decrease was not noted in the case of the sweptback plan form with either subsonic or supersonic leading edges. The rectangular plan forms of low aspect ratio and trapezoidal plan forms of moderately low aspect ratio with raked-out tips apparently are the most satisfactory plan forms for providing positive dihedral effect. At the larger aspect ratios these two plan forms provided negative dihedral effect over at least part of the Mach-Number range. The triangular plan forms and the sweptback plan form provided positive dihedral effects as long as their leading edges remained subsonic, but they provided negative dihedral effect when the leading edges became supersonic. The trapezoidal plan forms with raked-in tips yielded negative dihedral effect with subsonic tips but achieved zero dihedral effect over a limited sideslip range when the tips became supersonic. The general trend of the variation of the stability derivative of the rolling moment due to sideslip with Mach Number was a reduction in magnitude with an increase in Mach Number.

Tests on Four Circular-Back Aerofoils in the Compressed Air Tunnel. D. H. Williams, A. F. Brown, and C. J. W. Miles. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2301*, June, 1946. 35 pp., figs., tables. 17 references. British Information Services, New York. $2.05.

Tests have been carried out on four circular-back aerofoils (with flat undersurfaces) of thickness/chord ratios of 5, 10, 15, and 20 per cent. At $R = 0.3 \times 10^6$, a hump was observed in the lift curves at about $\alpha_0 = 0$, most marked on the thick sections. As R was increased the hump decreased until it disappeared at about $R = 4 \times 10^6$. Above that value of R, no further change was observed. There were very large scale effects on these models, shown best by plotting C_L at a given α_0 against R. The 5, 10, and 15 per cent sections were also tested with 5 per cent of the chord cut from the leading edge and then with a further 5 per cent removed and the nose rounded in each case. No appreciable changes were observed below $R = 2 \times 10^6$, but at higher values of R there were large increases in C_L max. due to the rounding. With the second rounding, C_L max. reached its highest value at about $R = 4 \times 10^6$ and decreased above that value due to earlier stalling. The effect of rounding on the 5 per cent section was small compared with that on the thicker sections. An appendix gives an account of previous work on circular-back sections carried out in other laboratories, and comparisons are made with results given in this report. The only previous work covering a wide range of thickness ratios was that of Gutsche, who went up to $R = 0.7 \times 10^6$. Good agreement was found with his results.

Supersonic Flow Past a Delta Wing at Angles of Attack and Yaw. R. C. F. Bartels and O. Laporte. *University of Michigan, Engineering Research Institute, Report No. CM 471*, May, 1948. 35 pp., figs. 13 references.

The conical flow past a delta wing that is restricted to lie entirely within its Mach cone is described in terms of an analytic function of a single complex variable. The function is determined by the boundary conditions corresponding to those to which the flow must conform at points on the surface of the body and at points on the Mach cone enveloping the body. In order to determine uniquely the conical flow past the wing for all angles of attack and yaw, the supplementary condition is imposed that the normal force coefficient of the wing be finite. The corresponding flow is such that the velocity along either edge is always infinite, except when the angle of yaw is equal to half the flare angle of the wing.

Transient Loading of Airfoils at Supersonic Speeds. John W. Miles. *Journal of the Aeronautical Sciences*, Vol. 15, No. 10, October, 1948, pp. 592–598, figs. 14 references.

Using the results for the pressure distribution over a supersonic airfoil due to a harmonic velocity distribution and the Fourier integrals for step and impulse functions, the pressure distribution and lift and moment coefficients have been calculated for the uniform entry of a flat plate into a sharp-edged gust and for the sudden deflection of a flap, the latter including the sudden pitching of the entire airfoil as a special case. Results are given in the form of algebraic equations plus curves for C_L and C_M for $M = 1$, $2^{1/2}$, 2, 4, and ∞.

On Airfoil Theory and Experiment. Alan Pope. **Letter to the Editor.** F. Cheers. *Journal of the Aeronautical Sciences*, Vol. 15, No. 10, October, 1948, p. 615, figs.

Investigation of the Effects of a Nacelle on the Aerodynamic Characteristics of a Swept Wing and the Effects of Sweep on a Wing Alone. Gerald Hieser and Charles F. Whitcomb. *U.S., N.A.C.A., Technical Note No. 1709*, October, 1948. 108 pp., illus., diagrs., figs. 4 references.

Test results show the effects of a nacelle on the aerodynamic characteristics of a wing at sweep angles of 0°, 45°, and −45°, and the effects of sweep on the wing alone (NACA 65_2-215 section) at sweep angles of 0°, 15°, 30°, 45°, and −45°. The Mach Number was varied from 0.13 to 0.61 for the wing-nacelle combination and from 0.13 to 0.70 for the wing alone. Lift, drag, and pitching-moment data are included. Pressure distributions and pressure contours are given for each configuration at various test conditions. Tuft studies of the flow over the wing-nacelle combination and wing alone were made.

Air Power (43)

A Plan for Air Power; America's Aircraft Industry Must be Able to Meet Mobilization Demands. Joseph T. McNarney. *Ordnance*, Vol. 33, No. 170, September-October, 1948, Section 1, pp. 115, 116, illus.

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New Weapons for Air Supremacy. B. W. Chidlaw. *Aero Digest*, Vol. 57, No. 3, September, 1948, pp. 50–53, illus., diagrs.

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The Navy-Army Air Team; American Air Power Must be a Well-Integrated Force. John D. Price. *Ordnance*, Vol. 33, No. 170, September-October, 1948, Section 1, p. 117, illus.

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Another Year of Progress; A Review of a Year of Growth in the Field of Aviation in Canada. *Aircraft and Airport*, Vol. 10, No. 8, August, 1948, pp. 25, 26, illus.

The RCAF Builds Up. Harry Chapin Plummer. *Aero Digest*, Vol. 57, No. 4, October, 1948, pp. 19–21, 110–112, illus.

North West Air Command (R.C.A.F.). Basil R. Clarke. *Aircraft and Airport*, Vol. 10, No. 9, September, 1948, pp. 23, 25, illus.

Civil Aviation in Ceylon. *The Aeroplane*, Vol. 75, No. 1942, August 27, 1948, pp. 251, 252, illus.

Airplane Design & Description (10)

Design Producibility Serves the Industry. I, II. Walter R. Jones and Harold M. Harrison. *Aero Digest*, Vol. 57, No. 2, 3, August, September, 1948, pp. 40–45, 97, 100; 98–100, 120, 123; illus., figs.

The aircraft designer, in addition to devising a structure that will operate efficiently, must make one that can be produced economically. The manufacturer must be free to increase his rate of production unhampered by restrictions inherent in the design. To attain this, due consideration must be given to production and inspection methods, the availability of materials, the cost of tooling, and the specification of tolerances and methods of attachment. The principles of design producibility are discussed under the general headings of general configuration, major breakdown, structure and equipment, and expansibility. The subheadings under these major divisions constitute a check list that may be applied to any aircraft design.

Design of Structural Components for Interchangeability. Frank McL. Mallett. *Product Engineering*, Vol. 14, No. 8, August, 1948, pp. 137–139, illus., figs.

The factors that determine the method of attachment of interchangeable structural components, and a classification of the types of tolerances encountered in modern component attachment designs. The selection of tolerances that require matched tooling can be avoided by the use of adjustable attachments. An example shows how a slotted serated pad used to attach one of a pair of clevises to its component makes it possible to specify larger tolerances and thus reduce the cost of production without introducing excessive play prejudicial to structural requirements.

Passing Through the Sonic Barrier; Three Papers Presented at Meetings of the Accademia Nazionale dei Lincei, on April 18th, 1946, and January 11th, 1947. G. A. Crocco. *Aircraft Engineering*, Vol. 20, No. 234, August, 1948, pp. 220–226, 248, figs.

A mathematical analysis of the thrust that theoretically can be obtained at supersonic speeds from turbojet and athodyd power plants. Since at Mach 3.5 the athodyd is three times as efficient as the turbojet and since at Mach 4.0 the athodyd still functions, the turbojet cannot be operated, although some combination of these two types of jet power plant might provide a means of propulsion at supersonic speeds which could also provide the thrust necessary for take-off and landing. Calculation of the resistance the thrust must overcome at supersonic speeds shows that such speeds could be both practical and economic. The loss of lift of the lifting airfoil in the transonic range presents a problem that might be overcome by eliminating the wings and obtaining a vertical thrust component by deflecting downward a portion of the mass of air ejected by the jet exhaust. An examination of the performance of high-speed subsonic aircraft indicates that supersonic speeds could be obtained by scaling up-present turbojet engines. Calculations indicate that the optimum altitude for obtaining supersonic speeds would be a lower altitude than that at which fuel consumption and thrust are minimum for a given velocity, because intake area and overall dimensions of the jet engine would be reduced.

Influence of Recent Civil Airworthiness Requirements on Aircraft Design. W. Tye. *Royal Aeronautical Society, Journal*, Vol. 52, No. 452, August, 1948, pp. 513–522, figs. 4 references.

An analysis of the effect of airworthiness requirements on wing and power loading, flap and control-surface design, structural strength, deicing systems, and crashworthiness of aircraft. It is impossible at present to learn whether the increased standards of safety have succeeded in effecting the best compromise between minimum accident rate and operating efficiency, but between 1926 and 1940 a downward trend in the accident rate can be noted which can be attributed, at least in part, to design.

Maintenance Design Questions. T. E. G. Bowden. *Royal Aeronautical Society, Journal*, Vol. 52, No. 452, August, 1948, pp. 523–525.

Answers to ten questions that could be used to check the standard of maintenance design of an airplane. They include: accessibility of component to be serviced; simplicity of removal; interference of surrounding structures; need for special tools, drills, gages, or materials; interchangeability of spare parts; and the effect of cold weather and rain on ease of maintenance.

An Aerodynamicist's Reply; Suggested Layout of a Small Tandem Four-Seater Pusher. P. R. Payne. *Flight*, Vol. 54, No. 2067, August 5, 1948, p. 164, cutaway drawing.

Throttle and push-pull steering wheel controlling elevons on the rear wing are the only controls that must be operated during flight. Flaps on the forward wing are positioned by a lever that has only two settings, up and down. Brakes can either be operated by pedals or linked to the steering wheel. Jet-rotated propeller blades are suggested as an alternate power plant.

We Need a Lightplane Revolution. William B. Stout. *Flying*, Vol. 43, No. 3, September, 1948, pp. 34, 50, 52, figs.

There is little prospect of obtaining substantial improvements in practicability and performance of conventional light aircraft. The design of a low-cost, vertical take-off, roadable personal airplane might well be based on the beating-wing principle employed in insect flight.

Ultra-Light Commentary; Aircraft and Engine Activities Today. *Flight*, Vol. 54, No. 2074, September 23, 1948, pp. 378, 379, illus.

The Plane Nobody Builds. Harland Wilson. *Flying*, Vol. 43, No. 4, October, 1948, pp. 38, 39, 64, 65, illus. Suggestions for a personal aircraft that would incorporate recent developments in aerodynamic design and power plants.

Manufacturers Push Cargo Planes. William Kroger. *Aviation Week*, Vol. 49, No. 9, August 30, 1948, pp. 17, 18.

Trends in Aircraft Research. E. H. Heinemann. *Automotive Industries*, Vol. 99, No. 7, October 1, 1948, pp. 36, 37, 60, figs.

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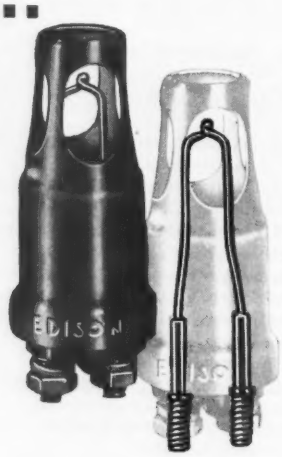

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Loads on and Behavior of Landing Gears During the First Phase of the Landing Impact. Walther Boccius. *U.S., Air Force, Technical Report No. F-TR-1172-ND (ATI No. 28561)*, August, 1948. 55 pp., diagrs., figs. 11 references.

The results of theoretical studies and data obtained from drop tests on revolving drums and from flight tests of the Me 262 and other German aircraft. The landing gear is represented by a system of springs and masses with damping effect. The drag forces introduced by the spin-up of the wheels can have an important effect on the spring behavior of the gear, as well as on the loads sustained by the system, since the coefficient of tire friction on concrete reaches values larger than 1.0. The characteristic curve of this coefficient is a function of slip between the wheel and the ground and depends on both adhesion and sliding. The variation of the drag force with time is calculated on the assumption that the vertical load is a linear function of time. An analysis of the effect of the wheel mass on the bending of the shock struts shows that the bending amplitudes both backward and forward are nearly constant for a large range of the natural frequency of the strut system. The drag forces subject the cantilever shock strut to high bearing loads and, hence, to large friction forces in the direction of the strut axis. These drag forces impair the initial applied force required to deflect the strut and the spring coefficient of the strut. The operation of the gear may be improved by spinning the wheels before landing, by sloping the shock strut, by using swing landing gear and forward torque links, and by lowering the spring coefficient of the strut. The test program with the Me 262 and the results of design modifications are reported.

Design Problems of the Cross-Wind Wheel. O. W. Loudenslager. *Shell Aviation News*, No. 121, July, 1948, pp. 19–21, illus., figs.

The mechanism and operation of the Goodyear cross-wind landing gear. The installation of this gear is expected to reduce take-off and landing accidents substantially. The castoring mechanism is contained entirely within the wheel hub, a fact that permits its installation on all types of landing-gear struts. The characteristics of the gear must be specially selected for each type of aircraft. Installations on heavy aircraft can be provided with locking devices that will remove the automatic castoring features at the will of the pilot.

Cross Wind Undercarriages. O. F. Maclaren. *Aeronautics*, Vol. 19, No. 4, September, 1948, pp. 88–90, illus., diagrs., figs.

Flying the Duck with the Goodyear Cross-Wind Wheels. D. A. S. McKay. *Aeronautics*, Vol. 19, No. 4, September, 1948, pp. 112, 115, illus.

Britain's Undercarriage Industry. *The Aeroplane*, Vol. 75, No. 1943, September 3, 1948, pp. 317–319, illus. Brief descriptions of the products of 11 manufacturers.

For Softer Landings; The History of the Airplane Tire. *Aircraft and Airport*, Vol. 10, No. 9, September, 1948, pp. 20–22, illus., diagr.

Undercarriage Testing; Some Notes on the Large Rig Developed by Dowty Equipment, Ltd., for Drop Tests of the Bristol Brabazon Landing Gear. A. E. Bingham. *Aircraft Production*, Vol. 10, No. 120, October, 1948, pp. 327–329, illus., diagr.

Summary Report on Cross-Wind Landing Gears. John H. Geisse and Lloyd Child. *U.S., Civil Aeronautics Administration*, May, 1948. 16 pp., illus., diagrs.

European Landing Gears. H. G. Conway. *SAE Journal*, Vol. 56, No. 8, August, 1948, pp. 50–55, diagrs., figs. (Extended summary of a paper: European Landing Gear Developments.)

The Structure of Wings. William Morse. *Aeronautics*, Vol. 19, No. 4, September, 1948, pp. 160, 163, 164, 167, 168, diagrs., figs. A study of the stresses carried by airplane wings and the methods currently used to accommodate them.

Air Intake System on Hermes IV. *Indian Aviation*, Vol. 32, No. 8, August, 1948, p. 236, diagr.

Stratocruiser Fuel Cells (Boeing 307). *Boeing Service Guide*, No. 12, September, 1948, pp. 2–7, diagrs., figs.

Power-Operated Controls (Saunders-Roe S.45 Flying Boat). *Modern Transport*, Vol. 59, No. 1533, August 14, 1948, pp. 11, 12, diagr.

Power-Operated Controls for the "S.R. 45" Flying Boat. *The Engineer*, Vol. 186, No. 4828, August 6, 1948, pp. 134, 135, diagr.

Russian Attack Aircraft: The TU-2 and The PE-2. *The Aeroplane*, Vol. 75, No. 1944, September 10, 1948, p. 352, illus., diagrs.

Russian Fighter Strength. *The Aeroplane*, Vol. 75, No. 1941, August 20, 1948, pp. 211, 212, illus.

Jet-Propelled Airliners. Nathaniel F. Silsbee. *Aero Digest*, Vol. 57, No. 2, August, 1948, pp. 46–48, 116, illus. A survey of British and American jet-engine development programs.

Spanish Revival; Aircraft Industry Gradually Overcoming Effects of Civil War. William Green. *Flight* Vol. 54, No. 2070, August 26, 1948, pp. 247–249, illus.

Technical Interest Seen in Racers (at 1948 National Air Races). *Aviation Week*, Vol. 49, No. 11, September 13, 1948, pp. 16, 17, illus.

More Original Designs Would Help National Air Races. Robert McLarren. *Automotive Industries*, Vol. 99, No. 7, October 1, 1948, pp. 38–40, 64, 66, tables.

U.S. Air Force Planes. *Aero Digest*, Vol. 57, No. 3, September, 1948, pp. 76–78, 80, 82, 84–86, 88, 90, 92–94, illus., diagrs. Descriptions of 16 airplanes.

New High Speed Planes for USAF. Robert Hotz. *Aviation Week*, Vol. 49, No. 13, September 2, 1948, pp. 12–14, illus.

USAF 'Unveils' Speed Designs. *Aviation Week*, Vol. 49, No. 11, September 13, 1948, pp. 25–27 illus.

Europe's Progress in Lightplanes; Design Details of Postwar Personal Aircraft. Sidney H. Fedan. *Aviation Week*, Vol. 49, No. 12, September 20, 1948, pp. 35, 37, 38, 41, 45, 46, 48, illus.

The S.B.A.C. Flying Display and Exhibition. I, II. *The Engineer*, Vol. 186, Nos. 4834, 4835, September 17, 24, 1948, pp. 283–285; 317–319, illus.

S.B.A.C. Souvenirs; Farnborough Exhibits in Action and Repose. *Flight*, Vol. 54, No. 2074, September 23, 1948, pp. 373–377, illus.

Transport Aircraft at the (S.B.A.C.) Show. *The Aeroplane*, Vol. 75, No. 1945, September 17, 1948, pp. 389–393, illus.

Notes on Aircraft Manufacturers' Exhibits. *The Aeroplane*, Vol. 75, No. 1945, September 17, 1948, pp. 395–397, illus., tables. Brief description of aircraft displayed at the S.B.A.C. exhibition.

Britain's Aircraft. *Flight*, Vol. 54, No. 2072, September 9, 1948, pp. 297–308, illus. Descriptions of 44 military, 33 civil, and ten research and development aircraft.

British Military Aircraft. *Flight*, Vol. 54, No. 2071, September 2, 1948, pp. 276, 277. A table of specifications and performance of 41 aircraft.

British Civil Aircraft. *Flight*, Vol. 54, No. 2071, September 2, 1948, p. 275. A table of specifications and performance of 33 aircraft.

The S.B.A.C. Display, Full Report From Farnborough: Some 40 New Aircraft: Excellent Progress in Gas Turbine Development. *Flight*, Vol. 54, No. 2073, September 15, 1948, pp. 339–359, illus., diagrs.

Civil and Military Aircraft (Tables of Aircraft Specifications). *The Aeroplane*, Vol. 75, No. 1943, September 3, 1948, pp. 313–315. Tables of specifications and performance of 34 civil and military transports; 34 military tactical and research aircraft; and 46 personal, training, and observation aircraft, helicopters, and sailplanes.

Pictorial Pre-View of the Ninth S.B.A.C. Display. *Aeronautics*, Vol. 19, No. 4, September, 1948, pp. 48–65, illus.

Britain Reveals New Plane Types (S.B.A.C. Exhibition). *Aviation Week*, Vol. 49, No. 12, September 20, 1948, pp. 14, 15, illus.

A Review of Britain's Aircraft Industry. *The Aeroplane*, Vol. 75, No. 1943, September 3, 1948, pp. 289–312, illus., diagrs. Descriptions of 56 aircraft and 19 power plants.

Armstrong Whitworth Apollo (4-Engined Transport). *The Aeroplane*, Vol. 75, No. 1939, August 6, 1948, pp. 157, 158, illus., figs.

Apollo; First Post-War Aircraft by Sir W. G. Armstrong Whitworth Ltd. *Flight*, Vol. 54, No. 2070, August 26, 1948, pp. 235–240, illus., diagrs., cutaway drawings.

Four-Place Plane for $2995? (Atlas Aircraft Co. H-10). *Aviation Week*, Vol. 49; No. 8, August 23, 1948, p. 18, illus.

A Flying Four (Avis), An Addition to the Auster Range, with Many Refinements. *Aeronautics*, Vol. 19, No. 4, September, 1948, p. 154, illus.

Canada's Avro C-102 (4-Engined Jet Airliner). *Aircraft and Airport*, Vol. 10, No. 8, August, 1948, p. 31, illus.

Avro 'Athena' Trainer. *Hawker Siddeley Review*, Vol. 1, No. 3, August, 1948, pp. 27, 28, illus., diagrs. With tables of weights and loads and performance.

Intentional Belly Landings (with Beech Twin-Quad Transport). *Southern Flight*, Vol. 30, No. 3, September, 1948, p. 18, illus.

The Boulton Paul Balliol (T.1 Prop-Jet Trainer). *Aircraft and Airport*, Vol. 10, No. 8, August, 1948, pp. 27, 49, illus.

Hermes IV; A First-Class Modern British Airliner for B.O.A.C.; Outstanding Operational Versatility. *Flight*, Vol. 54, No. 2075, September 30, 1948, pp. 403–408, 411, illus., cutaway drawings.

Flying the Cessna 170. Bob Wemple and Tom Ashley. *Southern Flight*, Vol. 30, No. 3, September, 1948, pp. 10, 11, 30, illus.

Flying the Cessna Crane. R. G. Worcester. *The Aeroplane*, Vol. 75, No. 1941, August 20, 1948, pp. 230, 231, illus., diagr.

The Convair-Liner. *The Aeroplane*, Vol. 75, No. 1944, September 10, 1948, pp. 359–361, illus.

The Convair Over Canada. *Aircraft and Airport*, Vol. 10, No. 9, September, 1948, pp. 32, 33, illus.

B-36 Engineering Modifications (Consolidated Vultee). Herbert W. Hinckley. *Western Flying*, Vol. 28, No. 10, October, 1948, pp. 14, 26, illus.

British DH-108 Hits Sonic Speed. *Aviation Week*, Vol. 49, No. 12, September 20, 1948, p. 13, illus.

Engineering Problems Resulting in Redesign of (Douglas) C-74 to C-124A. F. J. Stineman. *Western Flying*, Vol. 28, No. 10, October, 1948, pp. 12, 28, illus., diagr.

Navy Reveals New Night Fighter; Douglas Twin-Jet Sky Knight (F3D). *Aviation Week*, Vol. 49, No. 15, October 11, 1948, pp. 12, 13, illus.

Flying the Fokker Promotor. R. G. Worcester. *The Aeroplane*, Vol. 75, No. 1939, August 6, 1948, pp. 171, 172, illus.

The Hawker N7/46 (Naval Jet Fighter). *The Aeroplane*, Vol. 75, No. 1943, September 3, 1948, p. 339, illus.

A Hawker Occasion; First Public Demonstration of the N.7/46 Jet Fighter. *Flight*, Vol. 54, No. 2071, September 2, 1948, p. 257, illus.

Of Noble Descent; First Photographs of the Hawker N. 7/46 Nene-Powered Fighter. *Flight*, Vol. 54, No. 2066, July 29, 1948, p. 130, illus.

Hawker 'Sea Fury' F.B. MK.XI. *Hawker Siddeley Review*, Vol. 1, No. 3, August, 1948, pp. 25, 26, illus., diagrs. With tables of weights and loads and performance.

Experimental 4-Place with Auxiliary Jet (Johnson Bullet). *Southern Flight*, Vol. 30, No. 3, September, 1948, pp. 17, 24, illus.

Design Analysis: Lockheed (89) Constitution Transport. Robert McLarren. *Aviation Week*, Vol. 49, No. 9, August 30, 1948, pp. 20–22, 26, 27, illus., diagrs.

Developing a Successful Jet Trainer (Lockheed TF-80C). F. A. Smith. *Western Flying*, Vol. 28, No. 10, October, 1948, pp. 13, 26, illus.

Mooney Delivers First Plane (M-18 Single-Place Personal Airplane). *Aviation Week*, Vol. 49, No. 8, August 23, 1948, pp. 33, 34, illus.

Carrier-Borne Bomber; Composite Powered (North American) XAJ-1: P. and W. Double-Wasps and a G.E. Turbojet. *Flight*, Vol. 54, No. 2074, September 23, 1948, p. 380, illus.

"Fury" for the Navy (North American FJ-1). Edgar Schmued. *Aero Digest*, Vol. 57, No. 4, October, 1948, pp. 28–30, illus., diagr., cutaway drawing.

Achieving Short Field Performance Through Three-Engined Configuration (Northrop Pioneer and C-125 Assault Transport). Fred Baum. *Western Flying*, Vol. 28, No. 10, October, 1948, pp. 15, 26, illus.

Percival Prince; Design and Operational Features of an 8/10-Seater Feeder-Line Transport with Leonides Engines. *Flight*, Vol. 54, No. 2059, August 19, 1948, pp. 209–213, illus., cutaway drawings.

Percival Prince Progresses; Prototype Now Under Test; Aircraft for Feeder Services and Charter Work. *Modern Transport*, Vol. 54, No. 1535, August 28, 1948, p. 15, diagr.

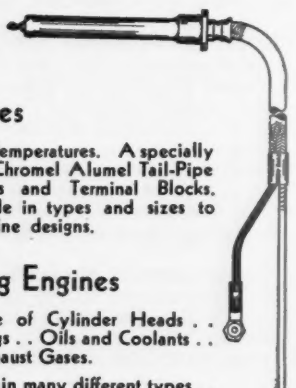
A New Feeder-Line Transport (Percival Prince). *The Aeroplane*, Vol. 75, No. 1941, August 20, 1948, pp. 215–219, illus., diagrs., cutaway drawing.

Percivals on Parade; The Prince Comes Out: First Demonstration of the Prentice T.Mk.2. *Flight*, Vol. 54, No. 2070, August 26, 1948, pp. 227, 228, illus.

Piper Family Cruiser. Leighton Collins. *Air Facts*, Vol. 11, No. 10, October 1, 1948, pp. 6–19, illus.

Flight Performance of (Piper) Family Cruiser Features Safety and Reliability. Ronald A. Keith. *Canadian Aviation*, Vol. 21, No. 9, September, 1948, pp. 20, 21, 56, illus.

THERMOCOUPLES



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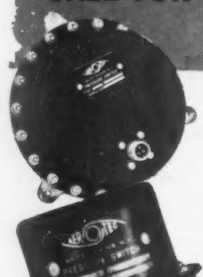

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Design and Conception of the First All-Magnesium Aircraft (Planet Satellite). J. N. D. Heenan. *Shell Aviation News*, No. 121, July, 1948, pp. 14–18, illus., diagrs., figs.

Description of the design details of the Planet Satellite, a four-passenger light aircraft. Magnesium-zirconium alloy is the principal constructional material. A forced-draft air-cooled engine, located behind the nose cabin, drives a propeller mounted behind a V-type empennage. A soundproof fire wall minimizes engine and propeller noise in the cabin. The use of a minimum number of parts and a maximum number of integral structural units makes small-scale production economical.

New Compromise for the (Ryan) Navion. *Flight*, Vol. 54, No. 2069, August 19, 1948, p. 218, illus., diagr.

The Saab-29 (Single-Seater Jet Fighter). *Saab Sonics*, No. 3, July–September, 1948, pp. 12, 13, illus.

SAAB Scandia in Britain; Demonstrations of Swedish Air Liner. *Modern Transport*, Vol. 54, No. 1535, August 28, 1948, p. 17, illus., diagr.

Flying the Saab Scandia. R. G. Worcester. *The Aeroplane*, Vol. 75, No. 1942, August 27, 1948, pp. 239, 240, illus.

Our Jet Fighter Flying-Boat (Saunders-Roe SR/A.1). *The Aeroplane*, Vol. 75, No. 1942, August 27, 1948, pp. 243–247, illus., diagrs., cutaway drawing.

Fighter Flying Boat; Description in Detail of the Saunders-Roe A1 Twin-Jet Design; Internally-Mounted Metrovick Beryls. *Flight*, Vol. 54, No. 2066, July 29, 1948, pp. 123–129, illus., diagrs., cutaway drawing.

An Ultra-Light; Slingsby Motor Tutor Developed From Glider. *Flight*, Vol. 54, No. 2068, August 12, 1948, p. 187, illus.

A Novel Amphibian (Sponson Developments, Ltd., Tribian Mk.I 2-Engined Amphibian). *The Aeroplane*, Vol. 75, No. 1940, August 13, 1948, p. 173, diagr.

The Sponson "Tribian"; A Small Amphibian of Very Clean Design. *Flight*, Vol. 54, No. 2066, July 29, 1948, p. 131, illus.

A Modern Military Specialist, the Valetta (Vickers Transport). D. West. *Aeronautics*, Vol. 19, No. 4, September, 1948, pp. 102–106, illus., diagrs.

Vickers Viking in Service with Indian National Airways; General Description. *Indian Aviation*, Vol. 32, No. 7, July, 1948, pp. 210–212, illus.

First Jet Transport (Vickers Nene-Viking). *Flight*, Vol. 54, No. 2066, July 29, 1948, p. 124, illus.

The Vickers Viscount (Jet Transport). *The Aeroplane*, Vol. 75, No. 1944, September 10, 1948, pp. 346, 347, illus.

Vickers "Viscount" Airliner. *The Engineer*, Vol. 186, No. 4833, September 10, 1948, pp. 267, 268, illus.

Viscount on View (Vickers); Exemplary Behaviour of World's First Turboprop Transport. *Flight*, Vol. 54, No. 2072, September 9, 1948, pp. 313, 314, illus.

Seagull Features Pivoted Wing (Vickers-Armstrong Amphibian). *Aviation Week*, Vol. 49, No. 12, September 20, 1948, p. 33, illus.

Russia's Fastest Service Plane; First Details Show New Yak Fighter Has Speed of 630 to 660 Mph. *Aviation Week*, Vol. 49, No. 14, October 4, 1948, p. 15, illus.

High-Lift Research; Youngman-Baynes Aircraft with Full-Span Slotted Flaps. *Flight*, Vol. 54, No. 2075, September 30, 1948, pp. 409, 410, illus., cutaway drawings.

Airports & Airways (39)

A Mathematical Theory of Airport Air Traffic Control. D. E. Olshevsky. *Cornell Aeronautical Laboratory, Report No. UA-519-P-1*, June 16, 1948. 33 pp., figs.

Prediction mathematics is used to obtain an analysis of aircraft traffic and scheduling in the traffic-control area at an airport. The analysis is used to determine the performance of a control system in which computer technique reduces position data, obtained from a surveillance system, to command information for automatic pilots. • The storage rate and the aircraft-in-storage number as a function of time are computed for an arrival schedule of 18 craft in 7 min., using one or more channels at uniform speed assignments and using three or more channels at staggered speeds in the ratio of 1.456, and for an arrival schedule of 50 craft in 14 min., using four or more channels at staggered speeds in the ratio 1:2.85. The quantities established that characterize dispatching efficiency include: the total delay in handling the airplane schedule, the amount of air storage required, speed stagger range, and the ratio of the average arrival rate during a traffic surge to the funneling rate.

A Preliminary Survey of Computer Applications to Air Traffic Control. Dwight F. Hamilton and Karl D. Swartzel. *Cornell Aeronautical Laboratory, Report No. UA-519-P-2*, October 1, 1947. 24 pp., figs. 6 references.

Three traffic-control patterns are considered. Each directs aircraft along a radial course to approach gate but can accommodate either traffic in which all craft may be given the same speed ratings which are segregated by sector or azimuth or traffic in which the different speed ratings are so numerous that the aircraft are segregated by altitude. Both the analog computer and the cyclic computer can be used to obtain the necessary data, program the estimated time of arrival, and control the course of the aircraft.

Flow and Airspace Occupancy Features of Air Traffic Control. Vernon I. Weihe. *Navigation*, Vol. 1, No. 11, September, 1948, pp. 237–239.

New York Radar Charts Air Traffic. Irwin C. Nye. *Aero Digest*, Vol. 57, No. 3, September, 1948, pp. 102, 104, 115, 116, illus.

Automatic Landing Approaches. *Airports & Air Carriers*, Vol. 14, No. 3, September, 1948, pp. 18, 32, illus.

British and American Stacking Patterns. *The Aeroplane*, Vol. 75, No. 1945, September 17, 1948, pp. 378, 379, diagrs.

Airport Lighting Tips. L. C. Vipond. *Aviation Maintenance & Operations*, Vol. 10, No. 4, September, 1948, pp. 36, 56.

Effect of Jet Aircraft on Airfield Pavements. W. R. Macatee. *Road Builders' Assn., Airport Division, Release*, October 4, 1948. 2 pp., figs.

How Thick Should a Runway Be? *Aircraft and Airport*, Vol. 10, No. 8, August, 1948, pp. 19–21, illus. A summary of work done by Dr. Norman W. McLeod for the Canadian Department of Transport.

Airport Leases and Contracts. II. Allen H. Barr. *Southern Flight*, Vol. 30, No. 3, September, 1948, pp. 34, 35.

Airport Terminal Design. II. Walther Prokosch. *Airports & Air Carriers*, Vol. 14, No. 3, September, 1948, pp. 20, 21, figs.

Work on London Airport; Select Committee Urges Acceleration; Problem of Freight Accommodation. *Modern Transport*, Vol. 54, No. 1535, August 28, 1948, p. 7, maps.

Monopolies on the Airport. John H. Frederick. *Southern Flight*, Vol. 30, No. 3, September, 1948, pp. 36, 37.

Airport Buildings. J. W. S. Brancker. (Brancker Memorial Lecture 1948.) *Airports & Air Transportation*, Vol. 3 (N.S.). No. 63, September, 1948, pp. 66–68.

All-Weather Flying (31)

ICE PREVENTION

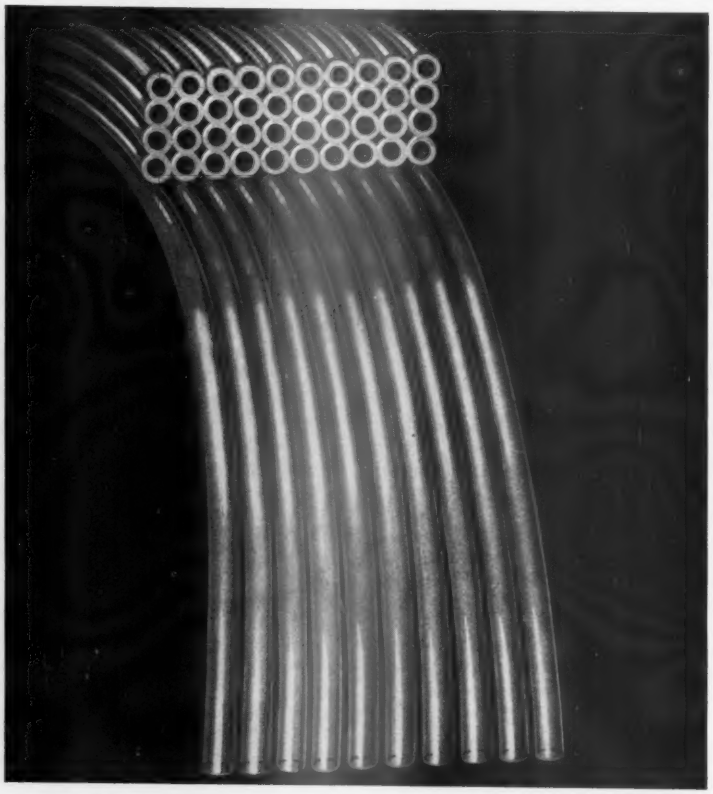
Calculation of Heat Required for Wing Thermal Ice Prevention in Specified Icing Conditions. Carr B. Neel, Jr. *SAE Quarterly Transactions*, Vol. 2, No. 3, July, 1948, pp. 369–378, figs. 18 references.

Flight-test data obtained with instrumented, heated airfoil sections during the winter seasons, 1945–1946 and 1946–1947, showed the meteorological conditions for which the wing must provide protection, the area of water impingement on the wing, the rate and distribution of impingement over that area, and the rate at which the water evaporates from the wing surface. An analysis of the data shows that, aft of the area of impingement, the efficiency of removal of water by evaporation decreases rapidly because this area is only partially wet. The larger the portion of the total amount of water evaporated in the area of interception, the greater the efficiency of the system becomes. Heating, therefore, should be concentrated as much as possible in the leading-edge region of a wing, which is the area of drop impingement, if an efficient thermal system is to be obtained.

High Test. Bernard Busson. *Aeronautics*, Vol. 19, No. 4, September, 1948, pp. 147, 148, 151, illus. The icing research laboratory of the French O.N.E.R.A. at Mont Lachat, in the French Alps.

Heat Anti-Icing for the Airlines. David North. *Western Flying*, Vol. 28, No. 9, September, 1948, pp. 15, 24, illus. (Extended summary of a paper.)

MULTI-CELL TAPES



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Atomic Energy (48)

Analytical Method of Determining Transmission of Particles and Radiation Through Great Thickness of Matter. A. E. Bobrowsky. *U.S., N.A.C.A., Technical Note No. 1712*, September, 1948. 35 pp., figs. 5 references.

A matrix method of determining transmission, scattering, and absorption of radiation, such as gamma rays and neutrons. Matrix methods appear to be immediately applicable for the solution of transmission problems, provided that adequate experimental data on scattering and absorption for standard thickness of absorbers are available.

Atomic Power for Aircraft. Andrew Kalitinsky. *Aero Digest*, Vol. 57, No. 2, August, 1948, pp. 58, 59, 121–123, figs.

The application of atomic power to aircraft propulsion could overcome the limitations of chemically fueled power plants and make possible the design of high-speed aircraft with practically unlimited range. In a closed-cycle turbine power plant, a turbojet, or a ram-jet engine, the combustor could be replaced by a nuclear reactor supplying heat to the working fluid. In a similar manner a rocket could be designed to use a low-molecular-weight propellant such as hydrogen. These designs would present problems in heat transfer between the reactor housing and the fluid and in the high-temperature properties of structural materials. The shielding of the reactor would be a considerable weight factor even if techniques were developed for the successive filtering of the emanations from the reactor pile. The concentration of the mass of the power-plant system at one point would probably require a design similar to recent thin-winged high-speed developments.

Harwell Activity at the Atomic Energy Research Establishment. *Flight*, Vol. 54, No. 2066, July 29, 1948, pp. 132, 133, illus.

Aviation Medicine (19)

Human Tolerance to High Linear Accelerations of Short Duration. William H. Ames. *Military Surgeon*, Vol. 103, No. 2, August, 1948, pp. 96–99.

Investigations conducted by the Air Materiel Command have determined that the automatic pilot-ejection seat must be accelerated from 0 to 60 ft. per sec. in order to clear the vertical stabilizer of an airplane traveling at 600 m.p.h. This would theoretically subject the pilot to a positive acceleration of 11.2 to 15*g*. Tests conducted on dummies and volunteer subjects with the 100-ft. tower vertical accelerator indicate that limits of skeletal tolerance established by German investigators of 20 *g*'s for 0.1 sec. and 25 *g*'s for 0.01 sec. are conservative. Since two subjects experienced 33 *g*'s for 0.005 sec. without serious injury a *g*-time tolerance curve for skeletal tolerance has been established which starts at 33 *g*'s at 0.005 sec. and reaches a plateau of 20 *g*'s at 0.1 sec. Since the subject and seat act as a system of two masses connected by a spring when acceleration is applied rapidly, the natural frequency of the system was excited, which resulted in overshooting of the acceleration on the subject. This not only resulted in accelerations in excess of the skeletal tolerance but produced peak accelerations that varied on different parts of the body. These undesirable effects were avoided by making the period of increasing acceleration greater than the natural frequency of the system. In order to avoid dangerous flexion of the lumbar spine and the neck, foot rests were located as low in the cockpit as possible and a headrest positioned the head so that its center of gravity was approximately in the line of thrust. Arm rests prevent violent spreading of the legs of the subject when the seat enters the slipstream and, by carrying the mass of the arms and part of the pectoral girdle, support 40 per cent of the weight carried by the first lumbar vertebra.

Problems of Human Engineering in Regard to Sudden Decelerative Forces on Man. J. P. Stapp. *Military Surgeon*, Vol. 103, No. 2, August, 1948, pp. 99–102.

A discussion of the problems, methods, and points of view of human engineering applied to the field of linear decelerative forces of rapid onset, brief duration, and high magnitude, and their effects on the living human body. The Aero Medical Laboratory of the Air Materiel Command has a linear Air Crew Decelerator under development at Muroc Experimental Air Base with which it expects to obtain data on the effects of linear decelerative forces of from 5 to 100 *g*'s peak magnitude lasting from 0.01 to 0.5 sec. and with a rate of application of 100 *g*'s per sec. to 10,000 *g*'s per sec.

An Investigation of the Relationship Between Visual Ability and Flight Performance. National Research Council, Committee on Aviation Psychology. *U.S., Civil Aeronautics Administration, Division of Research, Report No. 78*, July, 1948. 123 pp., figs. 9 references.

A controlled experimental study of 194 subjects was undertaken which covered a wide range of visual ability in order to obtain criteria for visual standards in the certification of civilian pilots. Subjects were given flight training during six academic quarters at the Ohio State University. Flight proficiency during, and at the completion of, the course was assessed according to general and specific aspects of flight performance. While a relationship was demonstrated between visual efficiency and proficiency in learning to fly light aircraft, many individuals with marked defects in vision were able to learn to fly sufficiently well to be granted licenses as private pilots. A number of individuals with impaired or monocular vision exhibited a proficiency equal, or superior to, the average of the students with normal vision. Subjects with severe visual deficiency displayed a proficiency in landing which was inferior to a statistically significant degree to the proficiency displayed by subjects with normal or near normal vision.

Man Girds for Supersonic Role. *Aviation Week*, Vol. 49, No. 13, September 27, 1948, pp. 21–24, illus. Research at the University of California on the effects on vibration, reaction time, altitude, escape, and other problems associated with high-speed, high-altitude flight.

Physiological Aspects of High Speed and High Altitude Flying. W. R. Lovelace. *S.A.E. National Aeronautic Meeting, Los Angeles, October 6–9, 1948, Preprint*. 13 pp. A summary of problems and research activities.

Maximum Flying Time for Air Crews. Birger Hannisdahl. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 293–295, 299, figs. 2 references. A proposal that the maximum number of hours of flying time for air crews take into consideration the relative duration of the periods of light and darkness during which they fly.

The Aviation Psychologist. J. A. C. Williams. *Aircraft Engineering*, Vol. 20, No. 235, September, 1948, pp. 269, figs. His part in the design of equipment, the selection of personnel, and the investigation of accidents.

Aircrew Selection; The R.A.F.'s Methods of Choosing Flying Personnel. *Flight*, Vol. 54, No. 2074, September 23, 1948, pp. 381, 382, illus.

Medicine-Men and Air-Men. *Aeronautics*, Vol. 19, No. 4, September, 1948, p. 111. Summary of a meeting of the British Medical Association on various aspects of aviation medicine.

Minnesota Multiphasic Personality Inventory; Differentiation of Psychologically Good and Poor Combat Risks Among Flying Personnel. L. Sherman Jennings. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 222–226, 237, figs. 7 references.

Methylene Blue, An Antidote to Altitude Sickness. Matilda Moldenhauer Brooks. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 298, 299. 2 references.

A Slide Rule for the Determination of "*g*" (Developed on Centrifuges). H. Silvette and S. W. Britton. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 296, 297, illus.

Practical Testing and Treating of Aircraft Drinking Water. Frederick Hopkins Shillito and Marguerite K. Peetz. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 287–292. 4 references.

Ruptured Intervertebral Disc From Positive Acceleration. Robert S. Shaw. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 276–278. 4 references.

Effects of Decompression; Seventy Subjects Repeatedly Exposed to a Simulated Altitude of 20,000 Feet During Approximately One Month. Harold A. Smedal and Ashton Graybiel. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 253–262, figs.

Sunburn as a Cause of Temporary Lowering of Blackout Threshold in Flyers. Ashton Graybiel, John L. Patterson, and John M. Packard. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 270–275, 278, figs. 4 references.

The Mechanical Properties of Human Bones. *U.S., National Bureau of Standards, Technical Report No. 1258*, August, 1948. 9 pp., illus., figs.

Stress-strain, flexure, and torsion data obtained from specimens of human bones show the average ultimate strength in compression to be about 23,000 lbs. per sq.in. The strength in bending

was slightly lower than that in compression, and the ultimate shear stress for the torsion to failure was about 15 per cent of the compressive strength.

Mechanical Properties of Human Bones. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 32, No. 10, October, 1948, pp. 118–120, illus.

The Effect of Wind on the Thermal Resistance of Clothing with Special Reference to the Protection Given by Coverall Fabrics of Various Permeabilities. P. Larose. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 25, No. 4, July, 1947, pp. 169–190, figs. 11 references.

AMC Develops Pilot's Pneumatic Anti-G Suit. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 20, October 15, 1948, pp. 6, 7, illus., table.

A Field Instrument for Measuring Volume and Instantaneous Flow Rate of Inspired Air. Leslie Silverman, Theodore Plotkin, and George Lee. *Review of Scientific Instruments*, Vol. 19, No. 8, August, 1948, pp. 513–526, illus., diagrs., figs.

Crash Survival Chances Measured. *Aviation Week*, Vol. 49, No. 9, August 30, 1948, p. 15, illus.

The Crash Injury Research project administered by Cornell University had determined that seat belts will not cause internal injury, shoulder harnesses could reduce incidence of serious injuries, and aircraft structures should be built to absorb forces and collapse under them before those forces act on occupants.

Simulated High Altitude Following Whole-Body Radiation of Mice. Willie W. Smith, Robert Dooley, and Edwin C. Thompson. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 227–237, figs. 7 references.

Comfortization (23)

The Fundamental Research Necessary for the Evaluation of Cooling Requirement of Supersonic Aircraft and Missiles. D. M. Patterson. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 20, October 15, 1948, pp. 13–22, figs.

In order to select intelligently on a weight basis the most economical refrigeration system for supersonic aircraft and missiles, research must be conducted to obtain appropriate data. Such research programs should determine by experimental, analytical, and laboratory investigation: the physical properties of air; the variation in intensity of solar radiation as a function of wave length, altitude, and latitude; the effective temperature of outer space expressed as a function of altitude; the influence of mean free path of the ambient atmosphere upon the physical properties of air, aerodynamic heating, and heat transfer phenomena; the solar and gray-body emissivities of various types of materials as a function of the temperature of the material; methods for the calibration of instruments for temperature measurements of the skin and boundary layer; the aerodynamic heating and heat transfer of various aerodynamic shapes in variable density supersonic flow; radiation absorbent materials or reflective coatings for transparent areas of aircraft; temperature gradients normal to the surface of transparent areas as a function of time; heat transfer by conduction and temperature distribution through various typical cross sections of structure; investigation of maximum allowable temperature for satisfactory performance of equipment and suitable cooling methods and the physiological requirements of personnel.

Measurements of Cabin Noise in Bomber Aircraft. D. Cameron and W. J. D. Annand. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2296*, January, 1942. 20 pp., illus., diagrs., figs. 1 reference. British Information Services, New York. $1.30.

Very-High-Speed Flight Requires Cabin Cooling. D. O. Moeller and O. A. Sanne. *SAE Journal*, Vol. 56, No. 8, August, 1948, pp. 46, 47, fig. (Extended summary of a paper: Jet Aircraft Cabin Temperature Control.) Cooling and pressurization requirements of the cabins of aircraft traveling at speeds in excess of 600 m.p.h.; and factors determining choice of cooling system and the use of air bled from the jet engine to heat the cabin.

Greater Comfort for the Airline Passenger. I—Cabin Silencing. Kenneth R. Jackman. *Aero Digest*, Vol. 57, No. 4, October, 1948, pp. 62, 63, 65–67, 119–122, figs. 8 references.

A survey of the standards of intensity and loudness and methods of measuring sound; data on the sensitivity and selectivity of the human ear; a summary of the reduction in noise level of aircraft cabin interiors obtained with various acoustic materials; and a comparison of the noise levels of current aircraft with those of railroads, buses, and automobiles. A list gives the principal design factors that must be taken into consideration to design an aircraft with satisfactory acoustical characteristics.

Lubrication of Cabin-Pressurization & Air-Conditioning Systems. I. D. N. Harris. *Aero Digest*, Vol. 47, No. 4, October, 1948, pp. 38–44, 108, diagrs.

Description of the cabin-pressurization and air-conditioning systems of the Lockheed Constellation, model Nos. 049, 149, 649, and 749. Includes layout, part numbers of the components, flow diagrams, lubrication systems, and lubricant specifications.

Comprehensive Graph for the Collection of Noise and Vibration Data. Stanley Lippert. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 279–286, figs. 15 references.

Data on noise and vibration given in any set of units, total excursion in inches, velocity, acceleration, decibels, or frequency can be spotted on the graph and interpreted immediately in any of the other units. A family of curves shows human response to vertical vibration and first approximations to the effects of fore-and-aft or lateral vibrations.

Pressurization, An Engineering Headache. *Aircraft and Airport*, Vol. 10, No. 8, August, 1948, pp. 22, 23, illus., diagr.

Hermes IV Interior; Layout of the 40-Seater Handley-Page Transport for B.O.A.C. *Flight*, Vol. 54, No. 2069, August 19, 1948, pp. 214, 215, illus.

New Cabin Blower Designs (Wade Engineering, Ltd.); Efficiency of Roots Type Increased. *Flight*, Vol. 54, No. 2075, September 30, 1948, pp. 414, 415, diagr., figs.

Control Cabins for Large Aircraft. Marvin L. Michael. *Western Flying*, Vol. 28, No. 10, October, 1948, pp. 16, 28, illus.

Electronics (3)

High Stability Radio Distance-Measuring Equipment for Aerial Navigation. H. Busignies. *Electrical Communication*, Vol. 25, No. 3, September, 1948, pp. 237–243, illus., diagr.

Description of recent developments at the Federal Telecommunications Laboratories and of crystal-controlled equipment that provides 51 clear two-way narrow-band channels in the 960–1215-megacycle aerial navigation band. At least 50 aircraft can be serviced by one beacon. Additional aircraft can be accommodated by beacons operated in parallel. Line-of-sight distances up to 100 nautical miles are measured with an accuracy at slant range of ±0.2 mile or 1 per cent, whichever is greater.

Aircraft Radio Communication Set A.R.I. 5272. E. C. Fielding. *Electrical Communication*, Vol. 25, No. 3, September, 1948, pp. 244–255, illus., diagrs.

The set described was developed in England during the war for use in carrier-based aircraft and is known commercially as the S.T.R.-9. Receiver and transmitter operate on 4 crystal controlled channels in the 115–116 megacycle range with an output of 3.5 watts. It is operable up to 40,000-ft. altitude. Range at 10,000 ft. is 200 miles between aircraft and 100 miles from aircraft to ground station. It operates off 26 volts d.c. with a power consumption of 180 watts (150 watts for receiver operation). Components are miniaturized as far as possible.

Position-Finding by Radio: First Thoughts on the Classification of Systems. C. E. Strong. (*Institution of Electrical Engineers (London), Journal*, Vol. 95, Pt. I, No. 85, January, 1948, pp. 31–35.) *Electrical Communication*, Vol. 25, No. 3, September, 1948, pp. 278–285, diagrs., figs. (See AER 3/48:59.)

Low Visibility Landings. *Aviation Maintenance & Operations*, Vol. 10, No. 4, September, 1948, p. 39, diagr.

Commercial broadcast stations are used as radio beacons. Positive identification of the station is made by having the station interrupt its program to announce its call letters and the airplane's flight number. Thereafter, code signals are superimposed on the station's program until the landing is made. Following identification by the station, the pilot uses his radio compass to guide him over the station and into the proper let-down course.

Effect of RTCA Program in Obtaining Regularity in Air Operations. D. W. Rentzel and Frederick B. Lee. *S.A.E. National Aeronautic Meeting, Los Angeles, October 6–9, 1948, Preprint.* 6 pp.

Snow Static on Aircraft. Willard H. Bennett. *Electrical Engineering*, Vol. 67, No. 10, October, 1948, pp. 947–953, diagrs., figs. 15 references.

Radio for Light Transport Aircraft. I, II. *The Aeroplane*, Vol. 75, Nos. 1939, 1940, August 6, 12, 1948, pp. 165, 166; 196, 197; illus.

Consol. A. H. Jessell. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 29–39, figs. A technical explanation of the principles of the German Consol radio-beacon navigational aid.

Radio Aids to Navigation. Robert Watson-Watt. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 15–21.

The Omni-Range. Leighton Collins. *Air Facts*, Vol. 11, No. 10, October 1, 1948, pp. 47–63, illus.

Miniaturized Radio Submerged in Freon Refrigerant. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 19, October 1, 1948, p. 10, illus.

The Development of Shipborne Navigational Radar. R. F. Hansford. *Institute of Navigation (London), Journal*, Vol. 1, No. 2, April, 1948, pp. 118–141, Discussion, pp. 141–147, figs., 10 pp. of illus.

Office-Size Electronic Computer (REAC, Reeves Electronic Analog Computer). Hubert H. Adise. *Aviation Week*, Vol. 49, No. 4, July 26, 1948, pp. 18, 21, illus., diagr.

A modification of a computer developed for the Special Devices Center of the Office of Naval Research, marketed commercially by Reeves Instrument Corporation. The solutions of high-order, ordinary, linear, and nonlinear differential equations are supplied by a six-channel oscillograph as permanent, directly readable records. The device may also be used for testing control mechanisms.

Compact Analog Computer. Seymour Frost. *Reeves Instrument Corporation*, 1948. 6 pp., illus., diagrs. (Reprint.)

Operation and facilities of a computer for obtaining dynamic solutions of the simultaneous differential equations usually encountered in design engineering. D.c. amplifiers add and integrate, while servos multiply or divide variables and resolve or add vectors.

Reeves Electronic Analogue Computer. *Reeves Instrument Corporation*, 1948. 16 pp., illus., diagrs.

Reeves Servomechanisms Components. *Reeves Instrument Corporation*, 1948. 10 pp., illus., figs.

Electronic Digital Computers. I—(Electronic Principles and Techniques). II—Discusses Electronic Counting Methods and Operation, Memory Devices, and Control Circuits. David Fidelman. *Radio & Television News*, Vol. 40, Nos. 3, 4, September, October, 1948, *Radio-Electronic Engineering*, pp. 3–5, 21; 10–13, 26, 27; illus., diagrs., figs.

The Miller Integrator. II—Non-Linearity, and Some Practical Circuits. B. H. Briggs. *Electronic Engineering*, Vol. 20, No. 247, September, 1948, pp. 279–284, figs. 3 references.

New Recording Test Equipment; Some Details of the Avimo Photo-Acoustic Apparatus for Obtaining Light and Sound Measurements. *Aircraft Engineering*, Vol. 20, No. 234, August, 1948, p. 233, illus.

Stabilization of Receiver Voltage in ASV Radar Homing Equipment. Herold. (*EIS/Her*, March 5, 1943.) *U.S., Air Force, Translation No. F-TS-4614-RE (ATI No. 19176)*, August, 1948. 14 pp., figs.

Aerial Navigation Aids Using Pulse Techniques. VIII. Sidney Moskowitz and Joseph Racker. *Radio & Television News*, Vol. 40, No. 4, October, 1948, *Radio-Electronic Engineering*, pp. 16–18, 20, 21, 29–31, illus., diagrs., figs. 10 references.

A discussion of the timing devices and electronic circuits used in the transmitters, receivers, and displays of pulse-radar sets, showing how normal and beacon radar have been employed in aircraft navigational-aid and traffic-control systems. The discussion includes the various modifications of IFF and NAVAR, DME, GCA, Teleran, and Loran.

Communication by Means of Reflected Power. Harry Stockman. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 10, October, 1948, pp. 1196–1204, illus., diagrs., figs.

An analysis of the potentialities of communication systems in which the carrier power is generated at the receiving end of the system and a modulated reflector replaces the transmitter. The basic theory of reflected-power communication shows that, by the use of properly designed antennas and reflectors, an inverse square propagation law may be realized rather than the inverse fourth power law that applies to conventional radar. The method may be used with radio, light, or sound waves. Reflectors have been constructed that impress an intelligible signal on the carrier wave by variable damping, modulation interference (or phase modulation), and directional modulation. Reflected-power communication may find application in meteorological balloon tracking, telemetering, and navigation and is expected to be highly directional, to eliminate fading, and to provide simple voice transmission without tubes, circuits, and power supplies.

An Instrument for the Rapid Production of a Decimal Series of Potentials and its Application to Ballistic Measurements. Howard S. Roberts and Harvey L. Curtis. *U.S., National Bureau of Standards, Journal of Research*, Vol. 41, No. 1, July, 1948, pp. 45–51, diagr., figs. Available also as *Research Paper No. RP1902*. U.S. Govt. Printing Office, Washington. $0.10.

An instrument that can be used to calibrate the deflections of an oscillograph which are produced by piezoelectric gages or by a velocimeter. The maximum potential to be calibrated was chosen as an integral multiple of 10 millivolts, with a maximum of 100 millivolts. To permit this choice, ten 10-ohm coils were connected in series, and a current of 1 milliamp. was sent through them. The decimal subdivisions of the chosen potential were obtained by varying the current in the ten 10-ohm coils in steps of 0.1 milliamp. from 0 to 1.0 milliamp. by shunt resistances. The calibration started with zero voltage when the shunt resistance was zero, and the shunt resistances increased in such steps that the current in the 10-ohm coils increased in 0.1-milliamp. steps and, hence, the output voltage in decimal steps of the chosen maximum potential. The shunt resistances were inserted by opening switches that normally short-circuited them. A general case is treated to show that a calibrator of this type may be used for any desired number of potential steps.

A Universal Telemetering System. L. Dale Harris. *Electrical Engineering*, Vol. 67, No. 10, October, 1948, p. 995, diagrs.

Frequency is employed as a translation medium. The quantity to be metered at a distance is translated to an equivalent frequency at the sending end for transmission over pilot wires, carrier current, or radio links. At the receiving end the frequency is converted back to a direct current or voltage in proportion to the original quantity being metered remotely. Vacuum tubes are used, and there is a minimum of moving parts, which often consist only of the meter at the receiving end.

A Solution of the Problem of Rapid Scanning for Radar Antennae. R. F. Rinehart. *Journal of Applied Physics*, Vol. 19, No. 9, September, 1948, pp. 860–862, figs.

The problem of devising a rapid scanning focusing antenna based on wave-guide principles has been solved only approximately and not too satisfactorily. A known property of a plane optical system with variable index of refraction is shown to satisfy the requirements of such an antenna system. By a suitable transformation, the plane variable refractive index system can be transformed into a surface of revolution of constant refractive index which reproduces the optical properties of the plane system. This surface provides an apparently practicable solution to the scanning problem. The diameter of the feed circle can be made arbitrarily small by judicious use of ellipsoidal reflector.

The Infra-Red Image Converter Tube. I. T. H. Pratt. *Electronic Engineering*, Vol. 20, No. 247, September, 1948, pp. 274–278, figs. 20 references.

Powder Diodes. II—The Rating of High-Vacuum Oxide-Coated Rectifiers. E. G. Rowe, R. E. Wyke, and W. Macrae. *Electronic Engineering*, Vol. 20, No. 247, September, 1948, pp. 285–287, 290, 291, figs.

The "Phantastron" Control Circuit. James R. McDade. *Electrical Engineering*, Vol. 67, No. 10, October, 1948, pp. 974–977, figs.

A New Quenching Circuit for Geiger Counters. H. Maier-Leibnitz. *Review of Scientific Instruments*, Vol. 19, No. 8, August, 1948, pp. 500–502, diagrs.

Frequency Stabilization of Microwave Oscillators by Spectrum Lines. II. José L. Garciá de Quevedo and William V. Smith. *Journal of Applied Physics*, Vol. 19, No. 9, September, 1948, pp. 831–836, diagr., figs.

The Velocity of Propagation of Electromagnetic Waves Derived from the Resonant Frequencies of a Cylindrical Cavity Resonator. L. Essen and A. C. Gordon-Smith. *Royal Society of London, Proceedings, Series A*, Vol. 194, No. 1038, September 2, 1948, pp. 348–361, diagrs., figs. 12 references.

A Microwave Secondary Frequency Standard. Robert R. Unterberger and William V. Smith. *Review of Scientific Instruments*, Vol. 19, No. 9, September, 1948, pp. 580–585, diagrs. 7 references.

A Study of the Ionospheric Data Obtained at Wuchang, Sept. 1946 thru Dec. 1947. P. H. Liang, H. L. Lung, and S. Wang. *Chinese Journal of Physics*, Vol. 7, No. 3, June, 1948, pp. 115–131, figs.

RPM and RHYTHM under the pilot's finger-tip control

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● CURTISS AUTOMATIC SYNCHRONIZATION makes propeller RPM control and engine RHYTHM a simple, one-lever, finger-tip operation for pilots of modern multi-engined airliners.

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A Note on a New Ionospheric-Meteorological Correlation. T. G. Mihran. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 9, September, 1948, pp. 1093–1095, figs. 16 references.

Investigation of the Ionosphere in the Case of Long Waves of Moderately Low and Very Low Frequencies (Project No. XE-12). Friedrich Vilbig. *U.S., Air Force, Technical Report No. F-TR-1182-ND (GS-USAF Wright Patterson Air Force Base No. 94), (ATI No. 26893)*, August, 1948. 19 pp., diagrs., figs.

An Experimental Investigation of the Radiation Patterns of Electromagnetic Horn Antennas. Donald R. Rhodes. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 9, September, 1948, pp. 1101–1105, figs. 6 references.

A Note on an Omni-Directional Array of Stacked V-Antennas. T. P. Pepper. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 26, No. 1, January, 1948, pp. 22, 23, illus.

The Radiation and Transmission Properties of a Pair of Parallel Plates. II. Albert E. Heins. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 215–220, figs.

New Developments in Flush-Mounted Antennas. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 19, October 1, 1948, p. 6, diagrs.

Properties of Barium-Magnesium Titanate Dielectrics. George R. Shelton, Ansel S. Creamer, and Elmer N. Bunting. *U.S., National Bureau of Standards, Journal of Research*, Vol. 41, No. 1, July, 1948, pp. 17–26, figs., tables. 7 references. Available also as *Research Paper No. RP1899*. U.S. Govt. Printing Office, Washington. $0.10.

Electrical Properties of Plastics. A. J. Warner. *American Society for Testing Materials, Bulletin*, No. 153, August, 1948, pp. 60–64, figs. 3 references.

Special Magnetic Alloys and Applications. G. W. Elmen and E. A. Gaugler. *Electrical Engineering*, Vol. 67, No. 9, September, 1948, pp. 843–845, figs. For contact rectifiers and magnetic amplifiers.

Thermomagnetic Generator. L. Brillouin and H. P. Iskenderian. *Electrical Communication*, Vol. 25, No. 3, September, 1948, pp. 300–311, figs.

The Theory of Magnetic Amplifiers and Some Recent Developments. E. H. Frost Smith. *Journal of Scientific Instruments*, Vol. 25, No. 8, August, 1948, pp. 268–272, diagrs., figs. 5 references.

Television From the Sky (Stratovision). *Western Flying*, Vol. 28, No. 9, September, 1948, pp. 17, 24, illus. (Extended summary of a paper.)

Capacity Transducer. Alvin B. Kaufman. *Radio & Television News*, Vol. 40, No. 3, September, 1948, *Radio-Electronic Engineering*, pp. 6, 7, 30, 31, illus., figs.

A device used by Douglas Aircraft Company for r.p.m. indication. The pickup consists of one or more insulated vanes located adjacent to the rotating shaft or attached blades in order to vary its vane capacity to ground with rotation of the shaft. The change of capacity is supplied to a capacity relay, which is a radio-frequency oscillator adjusted to oscillate feebly. The pickup is so connected that every time the capacity of the pickup increases it shunts the oscillator feedback circuit more and thus causes the oscillator to drop its radio-frequency voltage output. This alternative voltage, which is proportional to the shaft r.p.m., is supplied to an electronic frequency meter, the scale of which may be read in terms of r.p.m. The instrument may also be used for vibration analysis.

Studies in High Frequency Discharges. J. I. Lodge and R. W. Stewart. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 26, No. 4, July, 1948, pp. 205–229, illus., figs.

Precision Measurement of Electrical Characteristics of Quartz-Crystal Units. W. D. George, M. C. Selby, and R. Scolnik. *Institute of Radio Engineers, Proceedings*, Vol. 36, No. 9, September, 1948, pp. 1122–1131, figs. 7 references.

The Design of Transductor Circuits. II. (*ASEA Journal*, Vol. 21, No. 1–2, January-February, 1948, pp. 3–20.) *The Engineers' Digest*, Vol. 5, No. 6, August, 1948, pp. 281–283, figs.

Engineering Practices & Aids (49)

Conics in the Lofting of Streamlines. T. C. Campbell. *Aircraft Engineering*, Vol. 20, No. 235, September, 1948, pp. 270–280, figs.

A detailed treatment of the basic mathematical computation required in the use of conics for the development of aircraft contours. The solutions for the various types of curves are worked out and the method of matching curves is shown. The conventions used and the method of locating positions are those followed by the Blackburn Aircraft Company.

Things Not to Do in Drafting. *SAE Journal*, Vol. 56, No. 9, September, 1948, pp. 35–38, figs.

Equipment

S.B.A.C. Show Report: Materials and Components and Accessories. *The Aeroplane*, Vol. 75, No. 1945, September 17, 1948, pp. 401–406, illus., diagrs.

ELECTRICAL (16)

Safety and Aircraft Electric Equipment. T. B. Holliday *Electrical Engineering*, Vol. 67, No. 9, September, 1948, pp. 901–904.

A summary of a conference on aircraft safety. The equipment, power-plant, and air-frame manufacturers, as well as the customer and the C.A.A., are all concerned with the design, testing, and use of electric apparatus. The customer ultimately dictates the performance that is to be demanded of any equipment. The air-frame manufacturer has to assume responsibility for integrating the components of the systems into a whole. Protective devices should isolate defective circuits before the odor and smoke of burning insulation alarms the crew and should minimize the disturbance of the system voltage. The conclusions and recommendations of the conference are listed.

Fundamentals of A-C Circuit Interruption. I, II. Erwin Salzer. *Allis-Chalmers Electrical Review*, Vol. 13, Nos. 2, 3, Second, Third Quarter, 1948, pp. 20–24; 20–25; illus., diagrs., figs.

The Stratocruiser (Boeing 307) AC Power System. *Boeing Service Guide*, No. 11, August, 1948, pp. 2–8, illus., diagrs.

Lightweight Aircraft Battery. *The Engineer*, Vol. 186, No. 4830, August 20, 1948, pp. 194, figs.

A 24-volt, 25 amp.-hour seminonspillable storage battery (Type 12ZC11) designed by the Chloride Electrical Storage Company, Ltd. The battery is unspillable in any position within 70° of its normal upright attitude.

Connector Provides High Safety. Charles J. Adams. *Aviation Week*, Vol. 49, No. 13, September, 1948, pp. 28, 29, illus. A connector, developed by the American Phenolic Corporation, which uses cupro-nickel-tellurium contacts and which functioned satisfactorily after a 30-min. exposure to a 2,100°F. flame.

Recent Advances in Aircraft Ignition Systems; The Possibilities of a Low-Voltage Ultra-High Frequency Installation to Avoid Radio Interference. M. M. Comber. *Aircraft Engineering*, Vol. 20, No. 235, September, 1948, p. 282, diagr.

HYDRAULIC & PNEUMATIC (20)

Liquid Springs for Aircraft. H. Shawbrook. *Aero Digest*, Vol. 57, No. 2, August, 1948, pp. 53–55, 104, 105, figs.

An account of the problems encountered in the design, and the characteristics of glands that utilize the compressibility of liquids as a spring element in shock-absorbing devices. Aircraft landing-gear shock-absorber units that incorporate dash-pot action, developed by Dowty Equipment, Ltd., have a nearly linear curve in contrast with the hollow curve of oil-air shock absorbers. Installations in commercial aircraft have performed consistently without failure, and the only maintenance required was replacement of the hydraulic fluid.

The Servicing of Hydraulic Equipment. H. G. Conway. *Aircraft Engineering*, Vol. 20, No. 234, August, 1948, pp. 227–232, diagrs., figs.

Comprehensive notes for the aircraft mechanic on the basic principles of hydraulic-system maintenance. Discussion includes: types of hydraulic fluids and rubber; cleaning materials; pipe bending, cutting, installing, and connecting; types of seals, their removal and fitting; types of valves, their correct seating and testing; servicing of components; and filling, priming, bleeding, and trouble shooting the hydraulic system.

Liquid-Spring Progress (Dowty Equipment, Ltd.). *Flight*, Vol. 54, No. 2069, August 19, 1948, pp. 219, 220, illus., diagr.

Boost Devices for Aircraft Control Systems. N. S. Atwell. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 18, September 15, 1948, pp. 13–20, diagrs., figs. 2 references.

Illustrated is the new Bendix-Pacific Model TXV-2A Transmitter for 217 mc.

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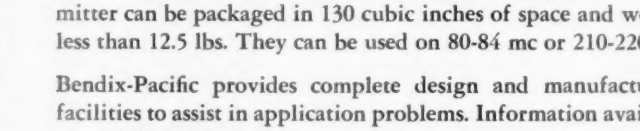

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High Pressure Hydraulic Control System (Air Associates, Inc.). *Product Engineering*, Vol. 19, No. 9, September, 1948, p. 93, diagr.

Fluid Pressure Drop Losses Through Smooth Straight Tubing. Domenic A. Di Tirro. *Product Engineering*, Vol. 19, No. 9, September, 1948, pp. 117–120, figs. Pressure-drop formulas for laminar and turbulent flow; chart and nomograph to simplify pressure-drop calculations; and test results verifying the method.

Frequency-Response Measurements of a Hydraulic Power Unit. M. R. Hannah. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 5, July, 1948, pp. 525–534, Discussion, pp. 535–539, illus., diagrs., figs. 7 references.

Aircraft Hydraulic Packings; Factors Influencing Their Performance. LaVerne E. Cheyney and T. J. McCuistion. *Mechanical Engineering*, Vol. 70, No. 8, August, 1948, pp. 675–679, figs.

A discussion of the types of sealing used in hydraulic systems, and the effect of the sealant material, diameter of the ring, groove design, surface finish of the articulating materials, age of the sealant, temperatures, pressures, and corrosive effect of the hydraulic fluid on the performance of the system.

What the Air Force Wants in Nonflammable Hydraulic Fluids. E. M. Glass. *SAE Journal*, Vol. 56, No. 9, September, 1948, pp. 55–59.

Air-Operated Automatic Controllers. Werner G. Holzbock. *Instruments*, Vol. 21, No. 8, August, 1948, pp. 710–714, diagrs.

Flight Safety & Rescue (15)

The Dornier-335 Pilot Ejection Seat (Project No. MQ-265). W. H. Kuntz. *U.S., Air Force, Technical Report No. F-TR-1191-ND (ATI No. 27204)*, August, 1948. 60 pp., illus., diagrs. 14 references.

The Dornier-335 ejection seat was developed during the latter part of World War II to provide a means of escape from high-speed aircraft. The seat is ejected from the airplane by a piston-type catapult, utilizing compressed air stored in three steel bottles of two liters capacity each, with pressure of 1,707 lbs. per sq.in. The system produced an ejection velocity of approximately 57.4 ft. per sec. at maximum accelerations of approximately 25*g*. The seat has a total vertical adjustment of $2^{7}/_{16}$ in. The seat back is parallel to the ejection angle, which is 13° from vertical.

Exit in Extremis; Latest Development of (Martin-Baker) Ejector Seat for High-Speed Escapes. *Flight*, Vol. 54, No. 2069, August 19, 1948, pp. 199–201, illus., figs., cutaway drawing.

Forced Ejection. P. J. Page. *Canadian Aviation*, Vol. 21, No. 10, October, 1948, pp. 18, 19, 40, 42, illus. Test parachutist's account of jumps with the Martin-Baker ejector seat.

New Pilot Ejection Seat is Developed by AMC. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No 17, September 1, 1948, pp. 6, 7.

Civil Aeronautics Administration Fire Protection Programme. J. C. Hromada. *Shell Aviation News*, No. 122, August, 1948, pp. 17–19, illus., diagr., fig.

What of Air Safety? Robin Beach. **Letter to the Editor.** Charles Froesch. **Author's Reply.** *Electrical Engineering*, Vol. 67, No. 9, September, 1948, pp. 928–932.

Problem of Air Safety. Robin Beach. *Skyways*, Vol. 7, No. 10, October, 1948, pp. 30, 31, 39, 40, illus.

Protecting Airports Against Electrostatic Fires. Robin Beach. *Airports & Air Carriers*, Vol. 41, No. 3, September, 1948, pp. 14, 15, illus.

A Study of Methods of Intentionally Crashing Aircraft with Purpose Toward the Survival of Personnel. Howard R. Bierman. *Journal of Aviation Medicine*, Vol. 19, No. 4, August, 1948, pp. 238–252, illus., diagrs., figs. 3 references. A résumé of the techniques used by three pilots experienced in intentionally crashing aircraft for the motion-picture industry.

San Francisco's All-Weather Plan. *Aviation Week*, Vol. 49, No. 8, August 23, 1948, p. 12.

Fire Escape. *Aeronautics*, Vol. 19, No. 4, September, 1948, p. 79, diagr. Devices developed by the Lonconine Company to provide unobstructed and fire-free exits for aircraft occupants in the event of a crash.

Fire Prevention in Aircraft. W. G. Glendinning and J. W. Drinkwater. *Shell Aviation News*, No. 122, August, 1948, pp. 19–22, diagrs., fig. Recommended design for fire-detection and extinguishing systems for radial, in-line, and gas-turbine engines.

Aircraft Accidents, Can Chances of Survival be Increased? R. E. Hardingham. **Correspondence.** J. Carroll. H. C. Newton. R. A. B. Stone. H. C. Bevis. P. S. MacGregor. *Royal Aeronautical Society, Journal*, Vol. 52, No. 453, September, 1948, pp. 566–573.

Sad Accident Experience Cripples Flying Future. John R. Morgan. *Canadian Aviation*, Vol. 21, No. 10, October, 1948, pp. 28, 29, 54, illus. Air aviation insurance writer's point of view on nonair-line aircraft accidents in Canada.

New Flying Suit Includes Lift Vest, Emergency Kit. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 17, September 1, 1948, pp. 5, 6, illus.

All Purpose Flying Suit by AMC. *Plane Facts*, Vol. 5, No. 8, August, 1948, pp. 7, 8, illus.

All-Metal, Airborne Lifeboat Will Accommodate 15 Persons. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 17, September 1, 1948, p. 9.

'Chuting Motorboat for Sea Rescues. Devon Francis. *Popular Science Monthly*, Vol. 153, No. 3, September, 1948, pp. 111–116, illus.

Lightplane Floats to Rescue Boats (Edo Aircraft Corp.). William Kroger. *Aviation Week*, Vol. 49, No. 7, August 16, 1948, p. 17, illus.

Flight Testing (13)

Flight Research at High Subsonic Speeds. H. Davies. *Royal Aeronautical Society, Journal*, Vol. 52, No. 452, August, 1948, pp. 483–503, Discussion, pp. 503–512, figs.

A discussion of the value of, and the techniques developed at, the R.A.E. for full-scale flight testing at Mach Numbers in the vicinity of 8.5. Measurement of acceleration, control-surface angles, tab angles, stick forces, speed, altitude, incidence, and angle of yaw provide data that may be used to correlate the results of wind-tunnel tests with aircraft performance. Analysis of flight-test data serves also as a means of determining the effect of compressibility on the overall drag of an aircraft, section drag, change in slope of the lift curve, and variations in the overall stability and control characteristics of an aircraft.

Air Speed-Mach Number Chart (Project No. HP-308). Franz J. Huber. *U.S., Air Force, Technical Report No. F-TR-1184-ND (GS-USAF Wright Patterson Air Force Base No. 98) (ATI No. 26401)*, August, 1948. 5 pp., diagr.

The chart is similar to "A Simplified Chart for Determining Mach Number and True Air Speed From Air Speed-Indicator Readings," published by the N.A.C.A. In addition to the indicated air speed and the indicated pressure altitude, it employs the indicated free-air temperature and a thermometer coefficient correction, which permits the true air speed to be read directly without further calculation.

Principles of Flight Testing. II, III. *Aircraft*, Vol. 26, Nos. 10, 12, July, September, 1948, pp. 20, 21; 22, 42, 43; diagrs., figs.

II. Conversion formulas for setting up standard atmosphere tables; list of instruments required for flight testing; errors inherent in pitot-static and temperature-measurement systems and their correction; method of weighing aircraft with platform scales having electric weighing cells; and procedure for calculating the location of the center of gravity. **III.** Determination of the take-off flight path; methods of take-off; ICAO requirements; and nonstandard atmospheric conditions.

Giant Test Center Seen at Palmdale. *Aviation Week*, Vol. 49, No. 8, August 23, 1948, p. 24.

The Palmdale Airport on the Mojave Desert in California is to be expanded to an area of 5,000 acres. Twelve-thousand-ft. concrete runways will be built, and electronic controls capable of bringing in high-speed aircraft automatically from an approach range of up to 100 miles will be installed. Assembly and testing facilities will be available to manufacturers of experimental supersonic aircraft.

Temperature Measurements From Aircraft. Sven Svensson. *Saab Sonics*, No. 3, July–September, 1948, pp. 9–11, 24, illus., figs. General considerations and description of a resistance-wire instrument developed by Svenska Aeroplan Aktiebolaget.

New Radar, Plotting Board Method Obtains Flight-Test Data. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 18, September 15, 1948, pp. 6, 7, figs.

Improved Flight Recorders Expected From Airline Tests. William D. Perreault. *American Aviation*, Vol. 12, No. 8, September 15, 1948, pp. 23, 24, illus.

A Method of Analysis of V-G Records From Transport Operations. A. M. Peiser and M. Wilkerson. *U.S., N.A.C.A., Report No. 807*, 1945. 7 pp., figs. 3 references. U.S. Govt. Printing Office, Washington. $0.15.

Multiple Recorder Aids in Anti-Icing Study of Convair Liner. E. H. Davies. *Instrumentation*, Vol. 3, No. 4, Third Quarter, 1948, pp. 10, 11, illus., diagr. General design and operating principles.

Rockets on Rails. *American Rocket Society, Journal*, No. 74, June, 1948, pp. 66–68.

Description of the design, performance, and instrumentation of of the rocket sled at the Muroc Air Base built by Northrop Aircraft, Inc., for testing airfoils at supersonic speeds. Maximum speed of the sled was 1,019 m.p.h. Tests show that it is possible to construct an installation that will attain 1,000 m.p.h. and can be brought to a controlled stop on a track length of 10,000 ft.

Camera Catches Shock Waves in Flight. *Aviation Week*, Vol. 49, No. 11, September 13, 1948, p. 33, illus.

Fuels & Lubricants (12)

Thermodynamic Charts for the Computation of Fuel Quantity Required for Constant-Pressure Combination with Diluents. Donald Bogart, David Okrent, and L. Richard Turner. *U.S., N.A.C.A., Technical Note No. 1655*, July, 1948. 54 pp., figs., 8 fold. charts. 16 references.

The charts supplement those supplied with *N.A.C.A. Technical Note No. 1086* for the graphic calculation of the quantity of hydrocarbon fuel required to attain a specified combustion temperature when water, alcohol, water-alcohol mixtures, liquid ammonia, liquid carbon dioxide, liquid nitrogen, liquid oxygen, or combinations of these liquids are used as diluent or refrigerants. The charts can be used only for processes in which the final mixture is leaner than stoichiometric and for temperatures at which dissociation is unimportant. These processes include the ideal combustion process, and the combustion process with incomplete heat release from the primary fuel and from the combustible diluents. The charts take into account the effect of preheating the mixture of air and diluents and the effect of an initial water-vapor content in the combustion air on the required quantity of fuel. The stoichiometric fuel-air ratio with diluent additions can be determined graphically by the method presented.

Charts for the Computation of Equilibrium Composition of Chemical Reactions in the Carbon-Hydrogen-Oxygen-Nitrogen System at Temperatures from 2000° to 5000° K. Vearl N. Huff and Clyde S. Calvert. *U.S., N.A.C.A., Technical Note No. 1653*, July, 1948. 43 pp., figs., 10 fold. charts. 3 references.

In order to determine the equilibrium composition of a chemical reaction at selected temperatures, arbitrary values are assigned to two independent variables from which an exact equilibrium-composition total pressure and quantity of oxygen are computed. By a process of successive approximations the values of the two independent variables are so adjusted that the calculated total pressure and quantity of oxygen approach the desired value. Charts are provided to aid in the choice of the initial estimates and to effect their adjustment rapidly. Charts are included which may be used to calculate the partial pressures of the products of the reaction.

Induction Period Calculator. E. L. Korb. *American Society for Testing Materials, Bulletin*, No. 153, August, 1948, pp. 99–102, figs.

Aliphatic Halide-Carbonyl Condensations by Means of Sodium. Edgar A. Cadwallader, Abraham Fookson, Thomas W. Mears, and Frank L. Howard. *U.S., National Bureau of Standards, Journal of Research*, Vol. 41, No. 2, August, 1948, pp. 111–118, fig. 16 references. Available also as *Research Paper No. RP1909*. U.S. Govt. Printing Office, Washington. $0.10.

Mass Spectra of Octanes. Evelyn G. Bloom, Fred L. Mohler, J. H. Lengel, and C. Edward Wise. *U.S., National Bureau of Standards, Journal of Research*, Vol. 41, No. 2, August, 1948, pp. 129–133, figs. Available also as *Research Paper No. RP1912*. U.S. Govt. Printing Office, Washington. $0.10.

Facilities for, and Work Under Way in Gas-Properties Research. R. V. Kleinschmidt. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 665, 666.

Industry's Requirements for Data on Gas Properties. N. A. Hall. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 661–663.

I—Introductory Comments to a Series of Contributions on Gas Properties. F. G. Keyes. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 261, 622.

II—Molecular Constants From Spectroscopic Data. G. Herzberg. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 623, 624. 8 references.

III—Heats of Formation and Chemical Theromodynamic Properties. Frederick D. Rossini. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 625–629, tables. 33 references.

IV—Vapor Pressure, Specific Volume, *p-v-T* Data for H_2, N_2, O_2, CO, CO_2, Air, He, A, Hg. Serge Gratch. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 631–640. 154 references.

V—Vapor Pressure, Specific Volumes, and *p-v-T* Data for H_2O, NH_3, CH_4, C_2H_4 with Comments on Mixtures. F. G. Keyes. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 641–644, figs. 18 references.

VI—Dielectric-Constant and Refractivity Data. J. G. Miller. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 645–649. 67 references.

VII—A Summary of Experimental Determinations of Joule-Thomson Effects in Gases. H. L. Johnston and David White. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 651–654. 56 references.

VIII—Brief Review of Available Data on the Dynamic Viscosity and Thermal Conductivity for Twelve Gases. G. A. Hawkins. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 655–659. 133 references.

A Study of the Pro-Knock Activity of Various Substances. J. D. B. Ogilvie, S. G. Davis, A. L. Thompson, W. T. Grummitt, and C. A. Winkler. *Canadian Journal of Research, Section F, Technology*, Vol. 26, No. 6, June, 1948, pp. 246–263, diagr., figs. 20 references.

Symposium on Heating Value of Fuels; Discussion. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 7, October, 1948, pp. 823–829. 16 references.

Definitions of Heats of Combustion of a Fuel and Current Methods for Their Determination. E. F. Fiock, R. S. Jessup, and F. W. Ruegg. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 7, October, 1948, pp. 811–818, figs. 21 references.

Definitions and a discussion of the relationships that exist between high and low heat of combustion at constant volume and high and low heat of combustion at constant pressure. Heat of combustion can be determined by the oxygen-bomb calorimeter, the water-flow calorimeter, the recording gas calorimeter, and in some cases by chemical analysis. A description of the instruments and procedure and an analysis of results are included.

The Oxidation, Ignition, and Detonation of Fuel, Vapors and Gases. *Canadian Journal of Research, Section F, Technology.*

I—A Reaction Chamber Adapted to Determine the Effect of Antiknocks on the Rapid Oxidation of Fuel Vapor at High Temperatures. R. O. King. Vol. 25, No. 6, November, 1947, pp. 326–342, diagrs., figs. 8 references.

II—The Effect of Flow Configuration on the Velocity of the Oxidation Reaction in Pentane-Air Mixtures. R. O. King. Vol. 26, No. 1, January, 1948, pp. 36–56, diagrs., figs. 2 references.

III—The Cause of the Effect of Metallic Dope to Delay Detonation. R. O. King. Vol. 26, No. 2, February, 1948, pp. 125–150, figs. 18 references.

IV—The Cause of Detonation or Combustion Knock in Engines. R. O. King. Vol. 26, No. 5, May, 1948, pp. 228–240, fig. 25 references.

V—The Hydrogen Engine and the Nuclear Theory of Ignition. R. O. King, W. A. Wallace, and B. Mahapatra. Vol. 26, No. 6, June, 1948, pp. 264–276, figs. 15 references.

Rachemistry. II—Black Rocket Gunpowder. Alfred J. Zaehringer. *Rocketscience*, Vol. 2, No. 3, September, 1948, pp. 46–51, figs.

Oxidation. L. F. Marek. *Industrial & Engineering Chemistry*, Vol. 40, No. 9, August 28, 1948, pp. 1635–1642. 251 references. Includes a brief review of the use of hydrogen peroxide in connection with rocket propulsion.

Synthesis of 1,2,3-Trimethylbenzene, 1-Ethyl-3-Methylbenzene, and *m*-Xylene by Dehydrogenation of Corresponding Cyclohexene Intermediates. Thaine W. Reynolds, Earl R.

Ebersole, Joseph M. Lamberti, Henry H. Chanan, and Paul M. Ordin. *Industrial & Engineering Chemistry*, Vol. 40, No. 9, August 28, 1948, pp. 1751, 1752. 9 references.

Full-Scale Engine Performance Characteristics of Aviation Safety Type Fuels. W. J. Sweeney, J. F. Kunc, Jr., W. C. Howell, Jr., and O. G. Lewis. *Air World*, Vol. 1, No. 4, September, 1948, pp. 78–85, figs. 5 references.

What's Coming in Fuels and Oils? R. J. S. Pigott. *SAE Journal*, Vol. 56, No. 8, August, 1948, pp. 17–24, figs. (Extended summary of a paper: Developments in Fuels, Lubricants, and Lubrication.)

High Strength Hydrogen Peroxide for Rocket Propulsion. V. W. Slater and W. S. Wood. *British Interplanetary Society, Journal*, Vol. 7, No. 4, July, 1948, pp. 137–154, figs. 12 references.

A summary of the methods developed for the production of hydrogen peroxide of 90–95 per cent concentration. In Germany the principal commercial method was the persulphate process. In England the Laporte process was used, which employs the electrolysis of ammonium sulphate and sulphuric acid. The purification and concentration procedures used to treat the products of either process and to increase their concentration from 30–35 to 90–95 per cent are similar in that they contain a mist separator and a packed tower for fractionation. Descriptions of the physical properties, stability, corrosive effects, storage containers, and physiological action of high-strength hydrogen peroxide are included.

The Manufacture of Aviation Gasoline in Germany. U.S. Naval Technical Mission in Europe. *Gt. Brit., British Intelligence Objectives Sub-Committee, Miscellaneous Report No. 72 (Technical Report No. 145-45)*, July, 1945, 45 pp., tables. British Information Services, New York. $1.45. The supply, composition, and methods of synthesis of isoparaffins, aromatics, and base stocks used in Germany for reciprocating and gas-turbine engines.

A Worker-Consistometer for Lubricating Greases. S. A. McKee and H. S. White. *American Society for Testing Materials, Bulletin*, No. 153, August, 1948, pp. 90–98, illus., figs.

Guide for the Lubrication of Military Aircraft. E. M. Glass. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 16, August 15, 1948, pp. 15–25. 4 references.

Tables and graphs giving the characteristics of the major greases and lubricating oils used by the U.S. Air Force; viscosity-temperature characteristics of various oils based on their specification limits; the symbol, specification number, supersedance, and pertinent bulletins of approved products for the specification lubricants used by the Air Force; and typical applications in which the specification lubricants are used. Data are based on AN-L-32, "General Specification for Lubrication of Aircraft."

Gliders & Gliding (35)

Wings for One. W. E. Hick. *Aeronautics*, Vol. 19, No. 4, September, 1948, pp. 84–87, figs. Proposals for the design of a modernized version of the "hang-on" glider.

Avitruk, Latest in Gliders. *Plane Facts*, Vol. 5, No. 8, August, 1948, pp. 9, 10, 29, illus.

Gliders. *Flight*, Vol. 54, No. 2072, September 9, 1948, p. 311, illus. Brief descriptions of the gliders of 3 manufacturers.

Guided Missiles (1)

Full-Scale Free-Flight Ballistic Measurements of Guided Missiles. L. A. Delsasso, L. G. De Bey, and D. Reuyl. *Journal of the Aeronautical Sciences*, Vol. 15, No. 10, October, 1948, pp. 605–615, illus., figs. 11 references.

A review of the optical and electronic equipment used at White Sands Proving Ground to record the flight of guided missiles. Conventional acceleration cameras, phototheodolites, and precision-plate cameras were supplemented with specially designed tracking telescopes using refractors and reflectors of large focal length. Radar instrumentation was found to give sufficient information to obtain satisfactory trajectory plots, but, in order to obtain data sufficiently accurate to compute first and second differences, a method employing the Doppler effect was developed. The data obtained with DOVAP (Doppler Velocity and Position Instrumentation) are programmed for the ENIAC, which computes an 800-point trajectory and tabulates the coordinate data and the first and second differences between successive points from which the velocity and acceleration may be computed. This system has given comparatively good results on 14 out of 17 launchings in which it was used.

Determination of Base Pressure from Free-Flight Data. A. C. Charters and R. A. Turetsky. *U.S., Army, Ordnance Department, Ballistic Research Laboratories, Aberdeen Proving Ground, Md., Report No. 653*, March 30, 1948. 24 pp., illus., figs. 15 references.

The base pressure of a cone cylinder is computed by two methods. In the first, the retardation of the missile is measured in order to determine the pressure acting on the head, and the skin friction is calculated. The base pressure is obtained by subtracting the head pressure and the skin friction components from the total drag. In the second method, the wake angle is observed in photographs, and the base pressure is computed from Prandtl-Meyer flow around a corner. Both methods were used to calculate the base pressure of three cone cylinders of varying body length fired at the same Mach Number. The agreement between the two methods was satisfactory and justified the assumption that the base pressure increases with body length. Data obtained from one of the models, which was fired at a range of Mach Numbers, shows that the base pressure is a decreasing function of Mach Number.

A Radio Method of Studying the Yaw of Shells. C. C. Gotlieb, P. E. Pashler, and M. Rubinoff. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 26, No. 3, May, 1948, pp. 167–198, diagrs., figs. 6 references.

The fuse of a shell is replaced by a high-frequency radio transmitter and the radiated signal is recorded at a ground station. The angular oscillations of the shell produce corresponding changes in signal level. The system of forces and the equations of motion that were set up by Fowler, Gallop, Lock, and Richmond in their study are used to develop formulas by which the angular motion of the shell may be determined from the variations in the level of this signal. Experimental data were analyzed to obtain the force factors and the damping coefficient. The overturning moment coefficient was determined at a velocity of 1,350 ft. per sec., and the cross-wind force coefficient was found from the value of this coefficient for shells of various mass distributions. Average values of the damping factors were deduced by evaluating the exponents of decay of the yaw angle. From accurate measurements of spin, the spin-decay exponent and the spin-decay coefficient were also determined. The method is superior to the jump-card and photographic methods of yaw study in that it provides a continuous record over the whole trajectory, permits measurement of spin and spin decay, and requires no contact with the shell. The measurements are not confined to flat trajectories, and their accuracy is equal to, or better than, those of other methods. The technique requires special fuses and equipment and more time and labor for analysis than other methods. Trajectory data must be determined independently.

Experiments with the Sam Control Unit K-12 (Automatic Pilot). Kagerer and Haussermann. (*Peenemünde, Heeresversuchsanstalt, ZWB/PA/86/94*, October 17, 1941.) *U.S., Air Force, Translation No. F-TS-2138-RE (ATI No. 20495)*, September, 1948. 5 pp., figs.

By incorporating a pickoff of the angular acceleration, in addition to those already provided for the angular position, velocity, and acceleration, failure of the control could be avoided. Results of the investigation are given graphically.

Proposed Control Methods for Guided Missiles. Temme, Dantschler, Steinhoff, and others. (*EIS/14*, June 28, 1945.) *U.S., Air Force, Translation No. F-TS-2883-RE (ATI No. 19049)*, July, 1948. 5 pp.

A compilation by seven German scientists of the methods that were developed and proposed for the control of unmanned missiles from ground and air-borne installations or by target-seeking devices and for their fusing by optical, acoustical, magnetic, electrostatic, and high-frequency proximity fuses. Includes the method used in the A-4 for actuating cutoff of the propulsion unit at a preselected velocity.

Calculation of the Stability of a Spin-Free-Elongated Projectile. W. Liess and E. Weber. (*Göttingen, Aerodynamische Versuchsanstalt, Bericht 44/H/2, UM/3105*, June 6, 1944.) *U.S., Air Force, Translation No. F-TS-2433-RE (ATI No. 23023)*, September, 1948. 9 pp., figs.

Wind-tunnel tests at Mach 2.8 and 3.2 to compare the stability of two projectiles of 19 and 25 cal., respectively, differing only in their length, showed the fin effectiveness slightly reduced by thickening of the boundary layer near the rear of the elongated

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projectile. Its stability characteristics, however, were not seriously impaired.

Control of the Surface-to-Air Missile Rheintochter R III (Radio-Guided Rocket-Propelled). Auler. (*MX/RHB/G/1*, January 1, 1944.) *U.S., Air Force, Translation No. F-TS-3169-RE (ATI No. 1957)*, July, 1948. 2 pp., fig.

A discussion of the flight characteristics of the Rheintochter when guided by full-deflection operation of the control surfaces. The use of this technique and pneumatic actuation of the controls will afford the simplest control system. If the missile has a period of rotation in the vicinity of 5 sec., the error in directional control will be negligible.

Graphic and Analytical Method of Determining Flight Paths of Guided Missiles. (*Peenemünde, Heeresversuchsanstalt, PA/-4/19, ZWB/THG/41/9.*) *U.S., Air Force, Translation No. F-TS-2855-RE (ATI No. 1967)*, August, 1948. 24 pp., diagrs., figs.

The method developed by Heinrich and Richter, which, in special cases, may be used to find the path velocity, the tangent to the path, and the elevator angle of an automatically controlled aircraft, if its angle of sideslip is known as a function of time, has been developed into a graphic method. All four quantities—the path velocity, the path tangent, the elevator, and the angle of sideslip of an aircraft or missile that is controlled automatically in a vertical or a horizontal plane—can be determined. Starting with a more or less rough first approximate solution for the angle of sideslip, an improved second approximation, as in the original method, is constructed for the path velocity and the path tangent. This second approximation and the relationships introduced by the automatic pilot determine an improvement of the elevator angle and the angle of sideslip. Repeating the same process, but starting with the second approximation of the angle of sideslip, gives a third approximation for the quantities that determine the course of the aircraft. A numerical example is worked out to the second approximation and is found to provide sufficient accuracy for practical purposes.

Curves of Constant Decrement and Constant Frequency Within Range of Effectiveness of a Lateral Beam Control. W. F. Correll. (*Völkenrode, MAP/V/108R*, March, 1946.) *U.S., Air Force, Translation No. F-TS-3497-RE (ATI No. 4676)*, September, 1948. 37 pp., figs.

In order to determine the curves of constant decrement and of constant frequency within the range of effective control of a guided missile, the coefficients of the frequency polynomial which primarily determine the damping and the frequency of the disturbed movement of the center of gravity are represented as functions of the real and imaginary components of a pair of roots. The system of equations for these coefficients yield an inexchangeable conclusive transformation to generally valid curved coordinates, since each pair of coefficients correspond to two pairs of conjugated complex roots. Although the initial transformation is subject to various interpretations, it may be divided into two interchangeable conclusive representations that overlap in covering the effective range of lateral beam control. Therefore, known equations of differentiation may be applied to the inverted transformation in order to determine the effect of modifications of the control values on the decrements and the frequencies.

V-2 Rocket Tests. W. L. Clay. *SAE Journal*, Vol. 56, No. 10, October, 1948, pp. 58, 59, diagrs. (Extended summary of a paper: Results of V-2 Rocket Tests.)

Guided Missile Heat Is Problem; Temperatures Present Material and Structural Considerations Which Indicate the Advantage of Night Firings. Robert McLarren. *Aviation Week*, Vol. 49, No. 15, October 11, 1948, pp. 25, 27, figs. 5 references.

Commercial Possibilities of Guided Missiles and Pilotless Aircraft. A. P. Gertz. *Sperryscope*, Vol. 11, No. 6, Summer, 1948, pp. 14–17, illus.

The only prospective commercial application of the work being done in the development of guided missiles is in the cargo transport field. Even this application is of doubtful worth. The real peacetime value of this military research will be found in the basic development that has been done in automatic navigation; turbojet, ram-jet, and rocket engines and fuels; and structural materials that retain high strength and remain stable under extremes of heat and cold.

"Brains Trust." *British Interplanetary Society, Journal*, Vol. 7, No. 4, July, 1948, pp. 155–159.

Answers to questions asked at a meeting of the British Interplanetary Society. Questions included: the cause of aurora, the

regulation of temperature of the cabin of a space-ship, gravity-neutral and gravity-repellent particles, protection from harmful solar radiations in space, and the function of a regeneratively cooled motor.

Space Weapon Development. *Aircraft*, Vol. 26, No. 12, September, 1948, pp. 12–15, 44, illus., diagrs., cutaway drawing.

The Guided Missile; Development of the V-2 Rocket Began a New Era of Ordnance. C. F. Green. *Ordnance*, Vol. 33, No. 170, September-October, 1948, Section 1, pp. 96–98, illus.

The Australian Rocket Range. *Aircraft*, Vol. 26, No. 12, September, 1948, pp. 16, 17, 44, 45, illus. Organization and program of the Australian Long Range Weapons Experimental Establishment, which has a research center at Salisbury and the testing range at Woomera.

Guided Missiles. IV. A. R. Weyl. *The Aeroplane*, Vol. 75, No. 1937, July 23, 1948, pp. 101–103, illus., figs.

History of the German Army rocket-development installation at Peenemünde and the Air Force establishment at Traun, Austria. Includes an account of the German operational employment of the V-2 and of postwar launchings and developments in England and the United States.

Guided Missiles. VI. A. R. Weyl. *The Aeroplane*, Vol. 75, No. 1943, September 3, 1948, pp. 285–288, illus., diagrs.

Design, control systems, and operational employment of the following guided missiles and control systems: Fritz X-1; Hs.298, 293, 293D, 293H, 294, and 117 (Schmetterling); BV 246; Wasserfall; Feuerlilie; Hecht; Rheintochter; Enzian; X-4; X-7; and Beethoven (Mistal). Includes illustrations of the U.S. missiles: McDonnell KSD-1 (Gargoyle), Stooge, and OQ-19; the Hayot (1913) wing propulsive duct; and the Marconnet (1909) intermittent-jet propulsive duct.

Installations

UNDERGROUND (32)

Aviation Goes Below; Saab's Underground Factory at Linköping, Sweden. Hugo Bertler. *Shell Aviation News*, No. 122, August, 1948, pp. 14–16, illus.

Instruments (9)

Altimeter Lag in Simulated Dives and Climbs. *Instruments*, Vol. 21, No. 9, September, 1948, pp. 854, 856, illus., diagr. The N.B.S. calibration method.

Air Speed—Mach Number Chart. Franz J. Huber. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 17, September 1, 1948, pp. 18–22.

Instrument-Gear Standards and Design. G. W. Kuntny. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 739–743, figs. 16 references.

Primary Flight Instruments; A Visit to R.A.E. Farnborough. *The Log*, Vol. 8, No. 8, August, 1948, pp. 183–186, diagr. Proposed blind-flight instrument panel layout and modifications of instrument display suggested to increase pilot efficiency.

Automatic Aircraft Control. James L. Anast. *Navigation*, Vol. 1, No. 11, September, 1948, pp. 228–232.

Practical Value of Electrical Process Analog in Automatic Control Studies. R. M. Hutchinson, S. P. Higgins, Jr., and J. C. King. *Instrumentation*, Vol. 3, No. 4, Third Quarter, 1948, pp. 18–20, illus., diagrs. 4 references.

Stability Chief Approach Problem. H. C. Bostwick and Robert B. Roe. *Aviation Week*, Vol. 49, No. 7, August 16, 1948, pp. 27, 29, 30, figs.

The time lag inherent in manual control during the final low approach path of an instrument or ground-controlled approach landing and the consequent instability it introduces requires the development of automatic controls that will forstall hunting of the airplane to within 2 or 3 sec. of visual contact. The development of such controls will permit the current 200–500 ft. minimum ceilings for scheduled air-line operations to be lowered to permit all-weather scheduled service.

Primary Detectors for Measurements. E. E. Lynch and A. J. Corson. *Electrical Engineering*, Vol. 67, No. 9, September, 1948, pp. 849–859, diagrs., figs. 4 references.

The basic elements in any measurement system are classified functionally as primary detectors, intermediate means, and end devices. A standardized method of analysis is developed by which the steady-state and the transient operation of any primary detector may be obtained. A tabulation of the quantity measured, range, name, basic elements, input, physical effects output, and application of typical primary detectors for measurement of electrical, magnetic, and nonelectrical quantities provides a means of selecting a primary detector for a specific application. An additional table gives the important physical laws and effects used in the various detectors.

The Primary-Element Response. M. F. Behar. *Instruments*, Vol. 21, No. 8, August, 1948, pp. 691–698, figs. 4 references.

A review of the Newton-Harper law of thermometric lag. Departures in the response of primary elements to this law led to the development of calibrating facilities for the dynamic testing of response. Sketches are reproduced of numerous devices that accomplish this testing.

The Use of High Permeability Materials in Magnetometers; The Application of a Saturated Core Type Magnetometer to an Automatic Steering Control (for Ships). L. D. Armstrong. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 25, No. 3, May, 1947, pp. 124–133, diagr., figs. 2 references.

Magnetic Fluid Clutch to Improve Servomechanism Performance. *Instruments*, Vol. 21, No. 8, August, 1948, pp. 756, 758, 760–762, 764, diagrs. Development at the National Bureau of Standards.

New Flight Indicator Introduced; Sperry Develops Zero Reader to Make Instrument Flying Simpler and ILS Approaches More Accurate. *Aviation Week*, Vol. 49, No. 12, September 20, 1948, pp. 16, illus.

Stabilization of Carrier-Frequency Servomechanisms. II—Design Formulae for Proportional-Derivative Networks. Andrew Sobczyk. *Franklin Institute, Journal*, Vol. 246, No. 2, August, 1948, pp. 95–121, figs., tables.

Detailed design procedures and tables of values for the various types of proportional-derivative networks. Several forms of parallel "T" networks arise because there are five independent time constants in the network, but, in order to realize the desired transfer characteristic, only four conditions need be imposed. The remaining degree of freedom may be used to obtain the most suitable input and output impedances for the source and the load impedances with which the parallel "T" is to be used. The tolerance requirements on the components of parallel "T" and bridge "T" networks that are derived show that, if 1 per cent components are used at 60 cycles, the resonant frequency will lie between 56.4 and 63.6 cycles and the notch width (rejection band width) will be within 0.99 cycles per sec. of the correct value. In order to guarantee that the phase shift at 60 cycles is within 10°, the percentage deviation of each part must be less than nine times the reciprocal of the product of the carrier angular frequency and the derivative time constant.

Stabilization of Carrier-Frequency Servomechanisms. III—Method of Obtaining Required Carrier Phase-Shift. Andrew Sobczyk. *Franklin Institute, Journal*, Vol. 246, No. 3, September, 1948, pp. 187–213, figs.

Thermostatic Bimetal. Ernest R. Howard. *Product Engineering*, Vol. 19, No. 9, September, 1948, pp. 106, 107, 110, illus.

Flow Panel Eases Tank Selection. *Aviation Week*, Vol. 49, No. 9, August 30, 1948, p. 30, illus.

A "pictorial" cockpit panel devised by The Glenn L. Martin Company has been installed in the P4M Mercator. The control panel traces, by means of an illuminated path, the route traveled by the fuel from any of eight tanks to any of four engines and gives an instant picture of flow conditions.

Analysis of Tests on Positive-Displacement Meters for Liquid Hydrocarbons. E. E. Ambrosius. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 703–708, figs.

A New Periscopic Sextant. Virginia Withington. *Navigation*, Vol. 1, No. 11, September, 1948, pp. 210–215, figs.

The Kollsman Instrument Division of the Square D Company has developed a periscopic sextant that obtains horizontal reference by a damped pendulous mirror. It has two-power magnification and a true field of 15°. A Diemel-Black ball integrator effects a continuous moving average over any observing period up to 2 min. The sextant mount is easily installed in the top of the aircraft.

Aircraft Instrument Design. T. B. Holliday. *Product Engineering*, Vol. 14, No. 8, August, 1948, pp. 121–124, illus.

A general survey of the problems of aircraft instrumentation. Engine, fuel, navigation, and accessory instruments are grouped according to the type of indication: temperature, pressure,

quantity, flow, gyroscopic, and directional. A brief discussion of each group includes the principal methods that have been employed to sense the variable and its range; to transmit the data; for amplification; for conversion of the signal into an indication; and errors and their compensation.

The British Association. II—An Engineer's Problems in the Measurement of Stress and Pressure. J. G. G. Hempson. *The Engineer*, Vol. 186, No. 4835, September 24, 1948, pp. 303, 304. (Extended summary of a paper.)

A survey of the methods used to obtain measurements of pressures and stresses. The discussion of the various kinds of sensing devices, amplifying systems, and displays shows how closely they approach the requirements of an ideal instrument.

Altimeter Settings Within the European-Mediterranean Region. F. Ormonroyd. *The Log*, Vol. 8, No. 8, August, 1948, pp. 189–191.

A proposal that for each Flight Information Region a number of actual QNH values from selected airdromes and reporting stations be broadcast to enable the pilot to select the latest QNH value of the station nearest to his position for his altimeter setting. This practice would ensure definite vertical separation without sacrifice of safe terrain clearance.

"On Instruments." Preston R. Bassett. *Sperryscope*, Vol. 11, No. 6, Summer, 1948, pp. 2–6, illus. A history of aircraft instrumentation and methods of indication and cockpit display.

Design of Dials for Maximum Legibility. II—A Preliminary Experiment on Dial Size and Graduation. William E. Kappauf and William M. Smith. *U.S., Air Force, Air Materiel Command, Engineering Division, Aero Medical Laboratory, Memorandum Report No. MCREXD-694-1-N*, July 12, 1948. 21 pp., illus., figs.

A study of the effect of dial size and dial graduation on the speed and accuracy with which quantitative information can be obtained. Frequency of errors was primarily a function of the arc length of each unit on the circumference of the dial. The maximum reading accuracy was obtained for scale divisions representing ten units with about 0.06 in. arc length per scale unit. Speed and accuracy were essentially the same for the two dial sizes used, 1.4 in. and 2.8 in. diameter, but varied with the total number of units on the scale. Dials with a smaller range of values were read faster. If the range of scale values on a dial is to be increased, the circumference of the dial should be increased proportionately in order to maintain a constant degree of reading accuracy.

Instrument Misreading Seen Due to Misinterpretation, Not Poor Seeing. Walter F. Grether. *SAE Journal*, Vol. 56, No. 9, September, 1948, pp. 44, 45, fig. (Extended summary of a paper: Design of Instrument Dials for Ease of Reading.)

Laboratories, Aeronautical (50)

The Hydrodynamics Laboratory of the California Institute of Technology. R. T. Knapp, Joseph Levy, J. P. O'Neill, and F. B. Brown. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 5, July, 1948, pp. 437–457, illus., diagrs. 5 references.

Experimental Engineering Research Methods. C. E. Lucke. *Mechanical Engineering*, Vol. 70, No. 10, October, 1948, pp. 793–795.

Laws & Regulations (44)

The Air Registration Board. *The Aeroplane*, Vol. 75, No. 1943, September 3, 1948, pp. 273–277. Its organization and functions.

Lighter-than-Air (40)

Controlled-Altitude Free Balloons. Athelstan F. Spilhaus, C. S. Schneider, and C. B. Moore. *Journal of Meteorology*, Vol. 5, No. 4, August, 1948, pp. 130–137, diagrs., figs. 1 reference.

The design of ballast-release mechanisms and control techniques employed with plastic balloons to stabilize flight at a constant pressure altitude. A preliminary analysis is given of two successful flights. The balloons are for use in the direct measurement of air trajectories and lateral diffusion.

Machine Elements (14)

Radial Engine Cam Design Simplified. I—Relative Proportions of Lobe Height and the Four Radii of Multi-Lobed Ring Cams. II—Determination of Cam Lobe Dimensions to Conform with Acceleration Limitation. Glenn D. Angle. *Automotive Industries*, Vol. 99, Nos. 5, 6, September 1, 15, 1948, pp. 28–31; 38–45; figs.

Conjugate Action of Involute Helical Gears with Parallel or Inclined Axes. H. Poritsky and D. W. Dudley. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 193–214, figs.

Plain Sleeve Bearings; Materials and Design. *Product Engineering*, Vol. 19, No. 10, October, 1948, pp. 129–160, illus., figs. 31 references.

Bearing performance factors; design concepts; bearing types; engine bearings—requirements, materials, and current design; and porous, wood, carbon-graphite, cast-iron and steel, plastic laminate, rubber, and hydrodynamic bearings.

Friction at High Sliding Velocities of Surfaces Lubricated with Sulfur as an Additive. Robert L. Johnson, Max A. Swikert and Edmond E. Bisson. *U.S., N.A.C.A., Technical Note No. 1720*, October, 1948. 30 pp., illus., diagrs., figs. 11 references.

Kinetic friction experiments were conducted on steel specimens lubricated with sulphur-type extreme-pressure lubricants over ranges of sliding velocities between 50 and 8,000 ft. per min. and loads from 269 to 1,543 Gm. (126,000 to 225,000 lbs. per sq.in. initial Hertz surface stress). Supporting evidence was found for a theory that rate of chemical reaction is a limiting factor in lubrication by extreme-pressure additives of surfaces operating at high sliding velocities. Variations in load and sulphur concentration had no appreciable effect on the sliding velocity at which lubricant failure occurred.

Percentage Charts for Motion Analysis. H. R. Ross. *Product Engineering*, Vol. 19, No. 10, October, 1948, pp. 171, 173, figs.

High Speed Ball Bearing Lubrication. *Lubrication*, Vol. 34, No. 9, September, 1948, pp. 97–108, illus., diagrs., figs.

Vibration Isolation and Shock Mounting. Carl J. Bastien. *Product Engineering*, Vol. 19, No. 9, September, 1948, pp. 86–89, diagrs., figs.

The Load-Carrying Capacity of the Oil Film Between Gear Teeth. Ewen M'Ewen. *The Engineer*, Vol. 186, No. 4832, September 3, 1948, pp. 234, 235, fig. 5 references.

Temperature Distribution in the Bush of a Journal Bearing. D. Clayton and M. J. Wilkie. (*Engineering*, Vol. 166, No. 4303, July 16, 1948, pp. 49–52.) The *Engineers' Digest*, Vol. 5, No. 7, September, 1948, pp. 333–336, figs.

Vibration and Shock Mounts; Characteristics of Materials Used and Types of Available Vibration and Shock Mounts. Carl J. Bastien. *Product Engineering*, Vol. 19, No. 10, October, 1948, pp. 112–116, illus., diagrs., tables.

Maintenance (25)

Douglas Service, Vol. 6, No. 9, September, 1948. 20 pp., illus., diagrs.

Contents: Air Conditioning System—Functional Operation, Use of Controls, Turbine Switch Operation, DC-6. Cabin Windows—Recommended Cleaners and Removal of Scratches and Crazes, DC-6. Landing Gear Micro Switches, DC-6. Hydraulic Reservoirs—Basic Spares Reservoir, DC-4, DC-6. Propeller Operation—Reverse Pitch and Unfeathering, DC-6. DC-6 Air Conditioning System. Flight Controls—Rigging Procedure, DC-4. Main Landing Gear Bushing Chart, DC-3. Storage of Aircraft, General.

Douglas Service, Vol. 6, No. 10, October, 1948. 20 pp., illus., diagrs.

Contents: Fuel System Management—Recommended Method of Servicing and Operating 8- and 10-Tank Fuel Systems, DC-6. Electrical Symbols, DC-4, DC-6. Shock Strut Boot—Installation Prevents Corrosion, DC-4. Exhaust Stack Sizing—Check of Clearances to Reduce Wear and Leakage, DC-6. Hydraulic Trouble Shooting Chart, DC-3. Heater Cycling and Overheat Switches—Identifying Numbers and Settings, DC-4. Cabin Pressure Control Instruments—Addition of Resistors and Damping Device, DC-6. Fuel System Management—Operation of 8- and 10-Tank Fuel Systems, DC-6. Sealant Removal Tools, DC-4, DC-6. Landing Gear Warning Systems—Correction, DC-6 Pulley Brackets—Check for Proper Shimming, DC-6. Geneva

Loc Actuators—Rockwell of Drive Gear, DC-6. Flight Compartment Air Conditioning—Operation of Temperature Control and Windshield Anti-Icing Systems, DC-6.

Polishing Metal Aircraft is Maintenance Problem. *Canadian Aviation*, Vol. 21, No. 10, October, 1948, pp. 36, 38, illus.

TCA Finds Anti-Icing Maintenance an All-Year Airline Problem. *Canadian Aviation*, Vol. 21, No. 9, September, 1948, pp. 42, 44, 46, 56, illus.

The Aircraft and Engine Mechanic. P. E. Chorley. *The Technical Instructor*, Vol. 3, No. 8, August, 1948, pp. 18–23.

How to Install a Lightplane Windshield. *Airports & Air Carriers*, Vol. 14, No. 3, September, 1948, pp. 10, 11, illus.

Tinker Base's Storage Program. George Grow. *Plane Facts*, Vol. 5, No. 8, August, 1948, pp. 11–13, illus.

World's Largest Airline Maintenance Shops (Pan American World Airways, Miami, Fla.). *Aviation Maintenance & Operations*, Vol. 10, No. 4, September, 1948, pp. 37, 60, illus.

Quick Change Artistry. *Aviation Maintenance & Operations*, Vol. 10, No. 4, September, 1948, p. 40, illus. Power-plant change on a Boeing 307 Stratocruiser.

Management & Finance (45)

Special Issue: Procurement for U.S. Air Power. *Aviation Week*, Vol. 49, No. 10, September 6, 1948. 37 pp. of text.

Procurement organization, procedures, and programs of the U.S.A.F., U.S. Navy, N.A.C.A., Munitions Board, National Security Resources Board, Air Navigation Development Board, and C.A.A. Includes tables of organization; lists of appropriations, buying offices, and publications on procurement procedure; and sections on renegotiation, industrial planning, U.S.A.F. contract definitions, and U.S.A.F. property classifications.

Key Employment in Aircraft Centers (Table). *Aviation Week*, Vol. 49, No. 12, September 20, 1948, p. 22.

Job Evaluation; Some Further Notes on the Assessment of Work and Wages: Piece-Work Rating Systems. J. J. Gracie. *Aircraft Production*, Vol. 10, No. 119, September, 1948, pp. 318–320, figs.

Will the Aircraft Industry be Labor's Next Battleground? Robert McLarren. *Automotive Industries*, Vol. 99, No. 4, August 15, 1948, pp. 31, 85, 86.

How the Navy Buys. *Aviation Maintenance & Operations*, Vol. 10, No. 4, September, 1948, pp. 21–33, fold. charts.

Materials (8)

Symbols and Nomenclature for Fatigue Testing. *American Society for Testing Materials, Bulletin*, No. 153, August, 1948, pp. 36, 37, figs.

METALS & ALLOYS

The Application of Metallurgy to Aircraft Design. Leo Shapiro. *Aeronautical Engineering Review*, Vol. 7, No. 11, November, 1948, pp. 29–35, illus., figs., tables. 4 references.

For an aluminum alloy to be susceptible to precipitation hardening the added element must have a limited solid solubility in the base metal. The magnitude of this solubility must vary with temperature in such a way that, when the alloy is cooled rapidly, sufficient submicroscopic precipitate of an intermetallic compound is formed to harden the entire mass. The rate of diffusion of the precipitate must be such that precipitation can be forced to occur from the supersaturated solid solution but can be suppressed by rapid cooling. The solid solubility of metals depends on the differences in their crystal pattern, in the number of valence electrons, and in the atomic radii. The hardening of steel depends primarily on the difference in solubility of carbide in face-centered cubic and body-centered cubic iron. The purpose of alloying elements is to suppress this transformation of the crystal structure of the base metal to lower temperatures. Although at present metallurgical knowledge is insufficient to predict all the physical characteristics of a new alloy, it has proved adequate to enable the deliberate development of the high-strength aluminum alloy 75 S; a new type of corrosion-resistant steel that is age-hardenable to 240,000 lbs. per sq.in. and yet retain considerable ductility; welding techniques that eliminate weld cracking; and methods of producing metallic molybdenum and titanium.

Plastic Deformation of a Circular Diaphragm Under Pressure. A. Gleyzal. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 288–296, diagr., figs. 10 references.

The Influence of the Dimensional Factors on the Mode of Yielding and Fracture in Medium-Carbon Steel. I—The Geometry and Size of the Flat Tensile Bar. Julius Miklowitz. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 274–287, illus., diagrs., figs. 13 references.

The Interaction of Discontinuity Surfaces in Plastic Fields of Stress. Alice Winzer and G. F. Carrier. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 261–264, figs.

A fundamental solution for problems associated with discontinuity surfaces in the field of stress has been developed by W. Prager, but the accuracy with which it approximates the stress field obtained in actual materials under the same boundary conditions has not been established. The limited case is studied in which the discontinuity surfaces may intersect when they separate fields of constant stress. The results may be applied to more general intersecting fields.

Discussion of the Forces Acting in Tension Impact Tests of Materials. D. S. Clark and P. E. Duwez. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 243–247, figs. 11 references.

The General Proof of the Principle of Maximum Plastic Resistance. A. H. Philippidis. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 241, 242. 3 references.

The general proof of M. Sadowsky's variational principle for the ideal plastic body, which affirms that, among all statically possible stress distributions, the actual stress distribution in plastic flow requires a maximum value of the external effect necessary to maintain the flow.

A Generalized Deformation Law. E. A. Davis. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 237–240. 9 references.

According to Hooke's law the magnitude of infinitesimal elastic strains depends upon two independent constants. Equations are developed which express the magnitude and the distribution of the strains in terms of two independent functions of the stresses. One function is related to the stress-strain diagram, while the other is concerned with the distribution of the strains in a state of combined stress. The equations are easily adaptable to the relations between the strain rates and the stresses in combined stress-creep tests. Two independent functions are necessary, and the behavior under a state of combined stress cannot be predicted from data obtained in pure-tension tests.

The Institute of Metals. II—The Measurement of the Damping Capacity of Metals in Torsional Vibration. G. A. Cottell, K. M. Entwistle, and F. C. Thompson. *The Engineer*, Vol. 186, No. 4836, October 1, 1948, pp. 340–342. (Extended summary of a paper.)

A Law of Work-Hardening. A. M. Freudenthal and M. Reiner. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 265–273, figs. 13 references.

Based on the "blocking" theory of the strength of a polycrystalline metal, a law of work-hardening is derived and checked experimentally on mild steel deformed by wire-drawing up to a deformation of 4.6 in the logarithmic measure. The law correlates the recoverable strain work with the total work of deformation in a series of exponential functions, the number of which corresponds to the number of sizes of crystal grains present in the annealed state.

Stress-Strain Relations for Finite Elastoplastic Deformations. J. E. Dorn and A. J. Latter. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 234–236. 14 references.

The Stress-Strain Laws of the Mathematical Theory of Plasticity, a Survey of Recent Progress. William Prager. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 226–233. 50 references.

The Institute of Metals. II—The Micro-Hardness Testing of Metals. E. Wilfred Taylor. *The Engineer*, Vol. 186, No. 4835, September 24, 1948, pp. 307, 308. (Extended summary of a paper.)

Some Properties of a Mechanical Model of Plasticity. H. F. Bohnenblust and Pol Duwez. *Journal of Applied Mechanics*, Vol. 15, No. 3, September, 1948, pp. 222–225, figs. 4 references.

Experimental Studies of Biaxially Stressed Mild Steel in the Plastic Range. S. J. Fraenkel. *Journal of Applied Mechanics*. Vol. 15, No. 3, September, 1948, pp. 193–200, figs. 5 references,

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Aluminum Furnace Brazing. P. A. Koerner. *Machine Design*, Vol. 20, No. 9, September, 1948, p. 128, illus.

Stress-Corrosion Tests on High-Strength Aluminum Alloy Sheet. Hugh L. Logan and Harold Hessing. *U.S., National Bureau of Standards, Journal of Research*, Vol. 41, No. 1, July, 1948, pp. 69–85, illus., figs., tables. 5 references. Available also as *Research Paper No. RP1905*. U.S. Govt. Printing Office, Washington. $0.15.

The materials investigated were 24S-T, aged 0 to 12 hours at 375°F.; R301-T; bare and clad 75S-T; bare and clad R303-T275; and bare and clad R303-T315 alloys. The materials were exposed unstressed and stressed in tension to three-quarters of the yield strength in a sodium chloride-hydrogen peroxide solution and in a marine atmosphere. The zinc bearing alloys, 75S-T and R303-T, were also exposed while stressed by bowing, in a boiling 6 per cent NaCl solution. Corrosion damage was evaluated from losses in tensile strength and elongation. Commercial 24S-T material, aged 4 hours or longer, and the other alloys as supplied by the manufacturers, with the exception of the R301-T alloy, were resistant to stress-corrosion cracking.

Plastic Flow Characteristics of Aluminum-Alloy Plate. L. J. Klingler and G. Sachs. *Journal of the Aeronautical Sciences*, Vol. 15, No. 10, October, 1948, pp. 599–604, figs. 17 references.

Commercial hot-rolled $1^1/_2$-in. 24ST aluminum plate possesses a marked degree of crystallographic anisotropy. Tensile tests at various orientations showed that the yield strength is only slightly dependent upon the crystallographic anistropy. Ratios of the transverse strains to the longitudinal strain varied from -0.30 to -0.57, while for an isotropic material the ratio would be -0.50.

Tearing Experiments on Metal Sheets. P. W. Rowe and C. Gurney. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2282*, February, 1945. 6 pp., figs. British Information Services, New York. $0.55.

As combat damage to aircraft frequently involves tearing of metal sheet, it is of interest to compare the tearing resistance of different metals. The load to tear a tongue from metal sheets has therefore been measured. For a given material the tearing resistance was found to be proportional to the sheet thickness squared. Of the materials tested, mild steel has the highest tearing resistance, being about six times that of a magnesium rich alloy that had the least tearing resistance.

Bearing Strengths of Some Aluminum-Alloy Rolled and Extruded Sections. R. L. Moore. *U.S., N.A.C.A., Technical Note No. 1503*, September, 1948. 17 pp., illus., figs. 7 references.

Tests were made to determine bearing yield and ultimate strengths for several sizes of rolled and extruded 14S sections and of rolled 24S-T and 75S-T bar. Ratios of bearing to tensile properties previously proposed for aluminum-alloy sheet and plate appear equally applicable to rolled bar of 24S-T, 14S-W, and 14S-T in thicknesses up to 2 in. and to extruded 14S-W and 14S-T in thicknesses up to 1 in. For rolled 75S-T bar in thicknesses up to 2 in. and for extruded 14S-W and 14S-T bar in the thickness range of 1 to 2 in., lower ratios of bearing to tensile properties are proposed.

Age Hardening of Aluminum at Boeing Aircraft Co. *Instrumentation*, Vol. 3, No. 4, Third Quarter, 1948, p. 25, illus.

X-Ray Measurement of Strain in Metal. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 32, No. 10, October, 1948, pp. 113–115, illus., figs.

Temper Designations for Aluminum Alloys. *Materials & Methods*, Vol. 28, No. 3, September, 1948, pp. 105, 107, fig.

The Constitution of the Aluminum-Rich Aluminum-Cobalt-Iron Alloys, with Reference to the Role of Transitional Elements in Alloy Formation. G. V. Raynor and M. B. Waldron. *Royal Society of London, Proceedings, Series A*, Vol. 194, No. 1038, September 2, 1948, pp. 362–374, figs. 12 references.

Axial Fatigue Tests at Zero Mean Stress of 24S-T and 75S-T Aluminum-Alloy Strips with a Central Circular Hole. W. C. Brueggeman and M. Mayer, Jr. *U.S., N.A.C.A., Technical Note No. 1611*, August, 1948. 23 pp., illus., figs. 7 references.

Axial fatigue tests at zero mean stress have been made on 0.032- and 0.064-in. 24S-T and 0.032-in. 75S-T sheet-metal specimens $^1/_4$, $^1/_2$, 1, and 2 in. wide without a hole and with central holes giving a range of hole diameter d to specimen width w from 0.01 to 0.95. In general, the fatigue strength based on the minimum section dropped sharply as d/w was increased from zero to about 0.25. The fatigue stress-concentration factor was higher for 75S-T than for 24S-T alloy. Evidence was found that an extremely small hole would not cause any reduction in fatigue strength.

Stress-Corrosion Tests Evaluate Alloys. *Aviation Week*, Vol. 49, No. 12, September 20, 1948, pp. 25, 28, 30, illus. 1 reference. Summary of N.B.S. test results on 75S-T, R301-T, R303-T, and artificially aged 24S-T.

Stress-Corrosion Tests of High-Strength Aluminum Alloys. *U.S., National Bureau of Standards, Technical Report No. 1273*, August, 1948. 9 pp., illus.

75S-T, R-301-T, R303-T, and artificially aged 24S-T aluminum alloys were tested under tension in a hydrogen peroxide and sodium chloride solution and in a boiling sodium chloride solution to determine their resistance to corrosion. The correlation of the results of these laboratory tests with marine-atmosphere exposure tests under similar conditions indicated that the laboratory tests will predict with a high degree of accuracy the results to be expected under service conditions.

Principles of Protecting Metals with Organic Coatings. A. J. Eickhoff and W. E. Shaw. *Corrosion*, Vol. 4, No. 10, October, 1948, pp. 463–475, diagrs., figs. 23 references.

Stress-Corrosion of High-Strength Aluminum Alloys. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 32, No. 9, September, 1948, pp. 108–110, illus.

Selected Bibliography on Salt Spray Testing, 1935–1946. Lorraine R. Voigt. *Corrosion*, Vol. 4, No. 10, October, 1948, pp. 492–504.

Over 150 periodical references, most of which are annotated, classified under the headings of Apparatus and Testing Material Applications, and Advantages and Disadvantages. Sources for the bibliography were the subject file of The International Nickel Company, Inc., Chemical Abstracts; and The Journal of the Institute of Metals.

High Strength Aluminum-Zinc-Magnesium Alloy Development in Germany. H. Sutton and H. Crowther. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1770, Item No. 21*, June, 1948. 25 pp. British Information Services, New York. $0.90.

The development of experimental aircraft structural materials (Flw 3415 and 3425) intended to replace the copper-bearing alloys of the Duralumin type. The material developed by I. G. Farben used Cr and V as stabilizers, whereas that of the Vereinigte Leichtmetallwerke depended on a special heat-treatment to obtain stress-corrosion resistance. Results of laboratory and exposure tests and data on different types of cladding are summarized.

Chart for Determining Properties of Round Aircraft Tubing. Benjamin Ostlind. *Product Engineering*, Vol. 19, No. 9, September, 1948, p. 165.

The chart comprises several groups of empirical curves for determining the area of metal in the cross section, the D/T ratio, moment of inertia, and the radius of gyration of aircraft structural tubing.

Zirconium in Magnesium. Hubert Altwicker. *U.S., Air Force, Technical Report No. F-TR-1185-ND (ATI No. 27205) (GS-USAF Wright-Patterson Air Force Base No. 101)*, August, 1948. 19 pp., diagrs.

A report of the research on magnesium-zirconium alloy systems conducted at the Light-Metal Research Laboratories of the I. G. Farbenindustrie in Bitterdeld, Germany, between 1938 and 1941. The chief difficulty to be overcome in developing these low-alloy magnesium-metal systems was the relatively poor solubility of zirconium in magnesium. Two methods were used: in one, metallic zirconium was added to the melt and, in the other, zirconium salts. Data are given on the grain refinement obtained with the various compositions and alloying techniques and on the physical properties of cast, sheet, extruded, and welded specimens.

The Tensile Strength of Gas Welds in a Magnesium-Manganese Alloy. J. Pendleton. *Sheet Metal Industries*, Vol. 25, No 256, August, 1948, pp. 1628–1634, 1636, illus., figs. 8 references.

Examination of specimens of welded magnesium-manganese alloys DTD 120A, 348, and 259 showed that the scatter in tensile-test results is attributable to variation in the grain size of the metal immediately adjacent to the fracture. Regions of abnormal grain size were caused by tacking and restarting. Tensile tests of welded trinary alloys, Mg-Mn-Ce and Mg-Mn-Ca, were less susceptible to scatter caused by tacking and restarting. These materials gave considerably greater values of elongation than the binary alloy, although this ductility was not reflected in the elongation values of the welded specimens. In spite of the lack of

susceptibility of the trinary alloys to abnormal grain development, they were not recommended for welding because of their greater tendency to crack.

Lead Plating; Method of Deposition on Bronze Bearing Surfaces. H. Silman and M. F. E. Fry. (*Metal Industry*, Vol. 73, No. 3, July 16, 1948, pp. 48–50.) *The Engineers' Digest*, Vol. 5, No. 7, September, 1948, pp. 341, 342, diagr.

Nimonic Alloys. *Flight*, Vol. 54, No. 2074, September 23, 1948, pp. 383–385, figs., tables. A summary of the physical, mechanical, and creep properties of Nimonic alloys 75, 80, and 80A. This family of 80/20 nickel-chromium alloys was developed for gas-turbine applications that require limited creep deformation under load at high temperatures.

A Metallurgical Investigation of Two Large Discs of CSA Alloy. E. E. Reynolds, J. W. Freeman, and A. E. White. *U.S., N.A.C.A., Technical Note No. 1533*, September, 1948. 33 pp., figs. 6 references.

Results of a study of properties at room temperature and 1,200°F. of two large discs of CSA alloy. Data showed that aging treatment was beneficial to the rupture properties, while no effect in tensile, hardness, or time-deformation properties was observed; however, extrapolation indicated that beneficial effect would be lost at approximately 10,000 hours. Because processing procedure, heat-treatment, and chemical composition varied for the CSA alloy discs, bar stock, an as-forged disc, and discs of other alloys, direct evaluations of individual factors could not be made.

A Metallurgical Investigation of Two-Contour-Forged Gas-Turbine Discs of 19–9DL Alloy. J. W. Freeman, E. E. Reynolds, and A. E. White. *U.S., N.A.C.A., Technical Note No. 1532*, September, 1948. 37 pp., figs. 6 references.

One-fourth sections of discs of 19-9DL alloy were tested to determine the level of properties developed in large contour forgings of the alloy, to evaluate the effect of the temperature of hot-cold-work in these large forgings, and to show the degree to which the properties of bar stock could be reproduced in large forgings. When processed under similar conditions, the properties of 19-9DL bar stock are well reproduced in the large forgings. The relative properties of the discs of 19-0DL and discs of other alloys depended on the heat-treatment and hot-cold-work during forging as well as on chemical composition.

Low Temperature Fatigue Tests on Steel. M. Hempel. (*Kaiser Wilhelm Institut für Eisenforschung, ZWB/FB/1704/1*, December 18, 1942.) *U.S., Air Force, Translation No. TS-1855-RE* (*ATI No. 18475*), 73 pp., illus., diagrs., figs. 8 references.

Tensile, fatigue, bar-impact, and hardness tests were conducted with 14 types of steel used in aircraft structures at temperatures of 20° and −78°C. to determine the relation between their endurance limit and their mechanical properties, the shape of their Woehler curves within the range of their time strength and endurance limit, the change of the time-strength and notch-effectiveness coefficient with tensile strength and temperature, and their fatigue-strength diagrams. Woehler fatigue tests were carried to a stress-cycle number limit of 5,000,000. As the temperature decreases, the endurance limit at a constant stress-cycle number increased for smooth bars but showed little change for notched bars. The increase of the endurance limit was closely related to the values of the yield point and the tensile strength at the different temperatures. At low temperatures the yield point, tensile strength, and Brinell hardness of the specimens increased while the notch impact toughness decreased. The stress-cycle diagram showed no basic change in the alternating-stress or tensile-strength curves in contrast with those for the endurance limit. The notch-effectiveness coefficients increased with stress-cycle number but were affected only slightly by changes in temperature down to −78°C. A method is given for the approximate determination of the stress limit lines in the fatigue-strength diagram which show the influence of the mean load on the tolerable stress vibrations. The method uses the values of the elastic limit, tensile strength, and endurance limit.

NONMETALLIC MATERIALS

Longitudinally Stiffened Thin-Walled Plywood Cylinders in Axial Compression. Edward W. Kuenzi and C. B. Norris. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1562*, April, 1948. 30 pp., illus., figs., tables. 3 references.

Results of tests of 1,050 specimens. When the spacing between the stiffeners was not too small and the stiffeners were sufficiently rigid, the average shell buckled at the critical stress of a complete unstiffened cylinder. When the stiffeners were more closely spaced, the buckling stress of the shell was greater than that of an unstiffened cylinder. A few specimens having heavy stiffened, sustained loads subsequent to buckling of the shell and finally failed because of general instability. An unstiffened shell of the same weight and curvature but of greater thickness than a stiffened shell had a load-weight ratio which indicated that theoretically it would buckle at greater or the same loads as the stiffened shell. When the stiffeners were heavy, the unstiffened shell of the same weight was theoretically capable of supporting two or three times the initial buckling load of a stiffened shell

Critical Buckling Strength of Stiffened Flat Plywood Plates in Compression and Shear-Closely Spaced Stiffeners. C. B. Norris, W. J. Kommers, and P. F. McKinnon. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1800*, February, 1948. 39 pp., illus., figs., tables. 3 references.

The equations derived in *Report No. 1316* for the critical stresses in flat plywood plates subjected to edgewise compression or shear were found from test results to be applicable to plywood stiffened with a multiplicity of parallelly placed stiffeners if the overall elastic properties of the stiffened plates are substituted in them. In these tests the elastic properties used were determined for the plates tested by auxiliary tests. Formulas are derived for the computation of the overall elastic properties of multiply stiffened plywood plates from the elastic properties of the plywood and the stiffeners and the dimensions and the spacing of the stiffeners. These formulas for the flexural stiffness in the direction of the stiffeners, flexural stiffness perpendicular to the direction of the stiffeners, shear stiffness, and flexural Poisson's ratio effect were verified by test and found to yield good approximations.

Torsional Buckling of Longitudinally Stiffened, Thin-Walled, Plywood Cylinders. Edward W. Kuenzi and C. P. Norris. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1563*, January, 1948. 12 pp., figs. 4 references.

Torsion tests of stiffened, thin-walled, plywood cylinders showed the buckling stress of the portion of the shell between the stiffeners to be about 85 per cent of the buckling stress of an unstiffened cylinder of the same curvature and thickness. The theoretical buckling torque of an unstiffened cylinder of the same weight and curvature as a stiffened cylinder was found to be greater than that of the stiffened cylinder.

Effect of Axial Stiffeners on the Buckling Properties of Thin Curved Plywood Plates in Axial Compression. Fred Werren and C. B. Norris. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1567*, March, 1948. 14 pp., illus., figs. 5 references.

The addition of an axial stiffener to a curved plywood plate in compression does not increase the buckling stress of the plywood. The effect of the stiffener is to carry additional load and, if stiff enough, to break up the buckle pattern. The theoretical buckling stress of thin curved plywood plates can be determined by the same methods used for a cylinder of finite length.

Effect of Length on the Buckling Stresses of Thin-Walled, Plywood Cylinders in Axial Compression. Edward W. Kuenzi. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1514, Revised*, March, 1948. 23 pp., illus., figs., tables. 3 references.

Data and analysis of results of tests performed on short, thin-walled, plywood cylinders loaded in axial compression. An empirical design curve is given for plywood cylinders of lengths shorter than the diameters which may be used with the design curves presented in previous reports for the buckling characteristics of cylinders of length greater than their diameter.

A Means of Determining the Hardness of Wood and Modified Woods over a Broad Specific Gravity Range. Richard C. Weatherwax, E. C. O. Erickson, and Alfred J. Stamm. *American Society for Testing Materials, Bulletin*, No. 153, August, 1948, pp. 84–89, figs. 17 references.

Tensile and Compressive Properties of Laminated Plastics at High and Low Temperatures. J. J. Lamb, Isabelle Boswell, and B. M. Axilrod. *U.S., N.A.C.A., Technical Note No. 1550*, July, 1948. 57 pp., illus., figs. 12 references.

Unsaturated-polyester laminate with glass fabric as reinforcement and several phenolic laminates with asbestos fabric, high-strength paper, rayon fabric, and cotton fabric as reinforcements were tested in tension and compression at 70°, 77°, and 200°F. The tensile strength of all the materials increased 15 to 33 per cent with change in the test temperature from 77° to −70°F., and the tensile modulus of elasticity increased 23 to 60 per cent. At 200°F. all materials except the asbestos-fabric laminate lost 20 to

40 per cent of their tensile strength at 77°F. and 15 to 30 per cent of their tensile modulus of elasticity. The corresponding losses for the asbestos-fabric laminate were 3 and 10 per cent. The glass-fabric laminate had the highest tensile strength and modulus of elasticity, 43,000 and 3,000,000 lbs. per sq.in., respectively. The compressive strength of all the materials increased 30 to 85 per cent at −70°F., and the compressive modulus of elasticity increased 10 to 60 per cent. At 200° F. the compressive modulus of elasticity increased 15 to 30 per cent. The glass-fabric laminate had the highest compressive strength and modulus of elasticity, 42,000 and 3,300,000 lbs. per sq.in., respectively.

Mechanical Properties of Five Laminated Plastics. William N. Findley and Will J. Worley. *U.S., N.A.C.A., Technical Note No. 1560,* August, 1948. 111 pp., illus., diagrs., figs. 25 references.

Results of mechanical tests of canvas laminate molded at low pressure, grade-C canvas laminate, rayon laminate, paper laminate, and glass-fabric laminate. Tests included static tension, compression, and torsion tests; long-time creep tests at different stresses on specimens loaded in tension; fatigue tests of unnotched specimens in bending; fatigue tests of notched specimens in bending; fatigue tests in bending at temperature of −75°, 77°, and 160°F.; and fatigue tests in torsion. Glass-fabric laminate had the most desirable mechanical properties for nearly all the properties measured. The properties of paper laminate were next in order of desirability.

The Effect of Radial Pressure on the Flow and Fracture of Reinforced Plastic Rods. C. Gurney and P. W. Rowe. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2283,* May, 1945. 10 pp., diagr., figs. 9 references. British Information Services, New York. $0.70.

Round rods of six different reinforced plastics were broken in simple tension, combinations of tension and radial pressure, and under approximately simple radial fluid pressure. Fracture under radial pressure had the appearance of being caused by longitudinal tension, and it occurred at much greater longitudinal strains than those at fracture in tension. The primary cause of fracture under radial pressure is considered to be the flow induced by shear components of the applied stress system. Flow destroys the regularity of the atomic arrangement or the arrangement of microscopic groups of atoms in materials and thus reduces cohesion. At the same time it sets up internal stresses that are especially large in heterogeneous materials such as reinforced plastics. With continued flow the internal stresses locally exceed those that the weakened material can withstand and cracks are formed. Fluid under pressure then enters the cracks and completes the fracture. The stress distribution in the test piece when loaded in the radial pressure apparatus, which was similar to that used by Bridgman, is not one of the simple radial stress, but the additional stresses are not thought to be primary cause of fracture of the plastic test pieces, although they may cause premature failure of more brittle materials such as mineral glasses.

Fracture of Glass Rods in Bending and Under Radial Pressure. C. Gurney and P. W. Rowe. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2284,* November, 1945. 5 pp. 5 references. British Information Services, New York. $0.45.

A simple theoretical argument leads to the conclusion that if Griffith's crack hypothesis is true, rods of brittle materials when subjected to radial pressure should fracture at a mean pressure equal to the average tensile stress at failure in a tensile test. In practice, it is not convenient to do tensile tests because of the difficulty of gripping the test pieces and of procuring axial loading. In the present series of tests, the mean radial pressure at fracture of three types of glass rod has been compared with the tensile stress at fracture computed from bending tests. The mean fracture stresses developed in the two types of test differ significantly though not greatly. When departures of the experimental test conditions from ideal conditions are considered, they appear adequate to account for the difference. The results, therefore, are not in disagreement with the deduction made from Griffith's crack hypothesis that fracture in radial pressure occurs at a pressure numerically equal to the tensile breaking stress.

Silicone Rubber, New Properties for Design Engineers. G. S. Irby, Jr., Wyman Goss, and J. J. Pyle. *American Society of Mechanical Engineers, Transactions,* Vol. 70, No. 7, October, 1948, pp. 831–836, illus., figs.

A New Adhesive for Metals. C. J. Moss. *The Aeroplane,* Vol. 75, No. 1946, September 24, 1948, pp. 423–425, illus., figs.

Araldite is a resin adhesive developed by Ciba, Ltd., Switzerland, which is suitable for bonding similar or dissimilar metals and for bonding glass and mica to metals. The resin is applied at 100°C. and cured at temperatures between 180° and 240°C. Pressure between the surfaces is needed only to keep the surfaces in contact with each other. The joints show little weakening after exposure for 10 days to water or common solvents.

Synthetic Resin Adhesives. *The Engineer,* Vol. 186, No. 4835, September 24, 1948, p. 309.

Synthetic-Resin Glues. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1336, Revised,* January, 1948. 21 pp.

The composition, manufacture, and properties of synthetic-resin glues. The form in which they are commercially available, gluing techniques, and durability of joints are discussed for high-temperature-setting, intermediate-temperature-setting, extended, and fortified urea resins; melamine-resins; and resorcinol-resin glues. Thermoplastic resins include polyvinyl-resin emulsion glues and polyvinyl-resin solutions. The one-stage and the two-stage processes for bonding metal to wood are explained.

Selection and Application of Plastics. Bernard Mack. *Materials & Methods,* Vol. 28, No. 3, September, 1948, pp. 91–104, illus., tables.

Methods for Measuring Dynamic Mechanical Properties of Rubber-Like Materials. A. W. Nolle. *Journal of Applied Physics,* Vol. 19, No. 8, August, 1948, pp. 753–774, diagr., figs.

Insulating Material Resists High Heat (American Latex Products Corp. Stabond FR-8 and FR-10). *Aviation Week,* Vol. 49, No. 14, October 4, 1948, p. 24.

SANDWICH MATERIALS

Flexural Strength and Stiffness of Wood-Aluminum Sandwich Panels. Roy A. Miller and Henry L. Langhaar. *Product Engineering,* Vol. 14, No. 8, August, 1948, pp. 104–108, figs.

A study, made by Consolidated Vultee Aircraft Corporation, of the structural properties of sandwich panels and columns composed of aluminum skins and cores of various kinds of woods showed that except for extremely short columns the most efficient core wood, on a weight-for-weight basis, is balsa wood. In the short-column range, the curves for all types of wood cores tend to converge and ponderosa pine was slightly superior to balsa. Disregarding limitations of thickness, in general, the efficiency of sandwich columns with wood cores varied inversely with the density. The maximum efficiency of balsa-aluminum shear webs and short columns was obtained with the grain of the core perpendicular to the skin. For medium and long columns the grain in the axial direction gave the greatest efficiency. Hardwood cores were found advantageous in sandwich panels carrying axial-compression loads because the thickness of efficiently proportioned balsa panels would make them impractical. An equation was derived for calculating the crippling stress for a balsa-aluminum shear panel. Small beams without flanges tested in shear and bending in the planes of the webs were found to have moduli of rupture between 75,000 and 90,000 lbs. per sq.in. A design equation for the proportions of sandwich panels with maximum stiffness for a given weight shows that a plain balsa board is stiffer weight for weight, than any wood-aluminum, wood-steel, wood-magnesium, or wood-fiber-glass sandwich. A balsa sandwich with the grain perpendicular to the cover sheets was found to have maximum stiffness for a given weight when the core was approximately twice the weight of the two cover sheets.

Methods of Test for Determining Strength Properties of Core Material for Sandwich Construction at Normal Temperatures. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1555, Revised,* March, 1948. 19 pp., illus. 1 reference.

An outline of the testing procedures that are used to determine the strength properties of core materials and of the glue lines between cores and faces in sandwich structures subjected to compression perpendicular to the plane of the sandwich and parallel to the plane of the sandwich and tension perpendicular to the plane of the sandwich. Shear tests include the determination of the modulus of rigidity in planes parallel to the faces of the plate and the torsion pendulum shear test for the determination of the modulus of rigidity in any plane. The outline gives directions for the preparation of the specimen and its mounting, the application of the loading, obtaining data for load-deformation curves, selection of the type of strain gage, calculation of the moduli, and the determination of the moisture content and specific gravity of the specimen.

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Methods for Conducting Mechanical Tests of Sandwich Constructions at Normal Temperature. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1556, Revised,* March, 1948. 26 pp., illus., diagrs., figs.

An outline of methods used in the testing of sandwich structures in edgewise and flatwise compression, flatwise tension, and flatwise bending. The shear strength of specimens is determined in both the flatwise and the edgewise plane, and a strip test is used to determine the energy required to peel or tear off one face of a sandwich specimen.

Fatigue of Sandwich Constructions for Aircraft; Aluminum and End-Grain Balsa Core Sandwich Material Tested in Shear. Fred Werren. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1559-B,* April, 1948. 13 pp., illus., figs. 1 reference.

Thirty specimens were tested to determine the shear fatigue properties of an assembled sandwich panel with aluminum facings and end-grain balsa core. At a ratio of minimum to maximum loading of 0.1, the fatigue strength at 30 million cycles was approximately 52 per cent of the static strength of the specimen for the conditions of loading used.

Buckling Loads of Flat Sandwich Panels in Compression; The Buckling of Flat Sandwich Panels with Either All Edges Simply Supported or All Edges Clamped (Cores of Paper Honeycomb and Facings of Glass Cloth Laminate). K. B. Boller. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1525-E,* March, 1948. 10 pp., figs., tables. 5 references.

Only one thickness of glass-cloth laminate facings and paper honeycomb core material was investigated. Various sizes and panels were tested to provide a wide range of critical stresses. Test results and computations show that the values of critical loads obtained from test panels with all edges simply supported are equal to the values obtained by substituting the mechanical properties of the materials in the formula presented in *Report No. 1525* and in its subsequent modification for the effects of transverse shear. The results of the test panels with all edges clamped, however, show the test values to be from 80 to 100 per cent of the calculated values. This deviation is attributed to imperfect clamping.

Effect of Shear Deformation in the Core of a Flat Rectangular Sandwich Panel. I—Buckling Under Compressive End Load. II—Deflection Under Uniform Transverse Load. H. W. March. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1583,* May, 1948. 31 pp., figs. 6 references.

The energy method is used to obtain an approximate determination of the effect of (a) shear deformation of the core on the buckling loads of sandwich panels having orthotropic facings and cores under compressive end loads and (b) increase in the central deflection of rectangular panels under uniform transverse loads when the edges are either all simply supported or all clamped. The panels were considered in compression with four different edge conditions: all edges simply supported, the loaded edges simply supported with the others clamped, the loaded edges clamped with the others simply supported, and all edges clamped. In applying the formulas for the compressive buckling loads to panels with isotropic facings that are stressed beyond the proportional limit, better agreement between observed and predicted loads is obtained by replacing the modulus of the facings by a reduced modulus. This substitution is theoretically valid for a panel acting as a column under compressive load when the shear deformation in the core is accounted for by the method of this report. Because compressive buckling loads are not usually defined sharply, the adequacy of the method is demonstrated by its application to the deflection of panels under uniform transverse load.

Repair of Aircraft Sandwich Constructions. Ed. Panek, and B. G. Heebink. *U.S., Forest Products Laboratory, Madison, Wis., Report No. 1584,* May, 1948. 32 pp., illus., diagrs., figs. 1 reference.

Description of methods developed for the repair of sandwich structures in which only the facings have been damaged; and one facing and the core, and both facings and the core have been damaged by a fracture accessible from one side and from both sides of the structure. Facing materials of aluminum, glass-cloth fabric, and plywood and cores of cellular cellulose acetate, cellular hard rubber, end-grain balsa, glass-cloth honeycomb, and paper honeycomb were used. The investigation was restricted to flat panels that were damaged by holes varying in size from that of a pencil to an area of several square feet. Round, oval, and square or rectangular patches were used in the repair. One exception was the glass-cloth glass-cloth honeycomb combination on which some work was done on single-curvature panels having a radius of 30 in. Plywood-faced specimens usually failed in the patch over the plug or in the scarf joint. Aluminum-faced specimens usually failed in the glue joint. The glass-cloth-faced specimens failed at or near the outer edge of the scarfed joint.

Meteorology (30)

An Analogy Between the Equatorial Easterlies and Supersonic Gas Flows. John C. Freeman, Jr. *Journal of Meterology,* Vol. 5, No. 4, August, 1948, pp. 138–146, figs. 20 references.

The equations governing wave motion and winds of the order of 10 to 40 m.p.h. at the interface of two adiabatic air masses are the same as those governing sound waves and gas flows of the order of 700 m.p.h. Since the equations for the flows are identical, the physical phenomena that characterize gas flows have analogies in the atmosphere. By extending the analogy between flow of a compressible fluid and flow of a fluid with a free surface to weather forecasting, the occurrence in the tropics of disturbances in the easterly stream, when the curvature of the isobars and the coriolis force are zero, is clarified, and a quantitative method of forecasting is provided which is based on the motion of finite disturbances on the tropical inversion.

Measurement of Air Temperature in the Presence of Solar Radiation. C. J. Brasefield. *Journal of Meterology,* Vol. 5, No. 4, August, 1948, pp. 147–151, figs.

A temperature element coated with a special white paint that reflects more than 90 per cent of the solar radiation was used to measure air temperatures to altitudes as high as 100,000 ft. With the element exposed directly to solar radiation the error in the measured air temperature was not more than 0.5° C. except at the highest altitudes. Temperatures measured with a radiosonde using an air duct for a radiation shield at altitudes from 50,000 to 100,000 ft. were from 3° to 20°C. higher than those obtained with the white element.

Aircraft Reconnaissance in Tropical Storms. Charles R. Coates. *U.S., Naval Institute, Proceedings,* Vol. 74, No. 547, September, 1948, pp. 1127–1133, illus.

A Laboratory Study of Visibility Through Clouds. G. O. Langstroth, M. W. Johns, J. L. Wolfson, and H. F. Batho. *Canadian Journal of Research, Section A, Physical Sciences,* Vol. 25, No. 1, January, 1947, pp. 49–57, diagrs., figs. 10 references.

Various opinions have been expressed regarding the importance of such factors as a "diffusing effect" due to small angle scattering in determining the visual range in a cloud. If a reduction of apparent contrast and an influence on brightness level are the only important factors, conditions at the obscuration point should be described by,

$$P = CB_t 10^{-\mu D}/B_t 10^{-\mu D} + B_c$$

where B_t denotes the brightness of an object that has a contrast C with its background; B_c and μD represent, respectively, the cloud brightness and optical density in the line of sight; and P denotes the contrast limen value. Experiments to test this relation have been performed with an ammonium chloride smoke in a chamber 1.8 m. long. The results indicate that the equation is adequate and that factors not taken into consideration in it play a negligible role in total obscuration under laboratory conditions. The experiments were performed at various brightness levels within the 1 to 100 millilambert range.

The Recognition of Objects Nearly Obscured by a Cloud. G. O. Langstroth, M. W. Johns, J. L. Wolfson, and H. F. Batho. *Canadian Journal of Research, Section A, Physical Sciences,* Vol. 25, No. 1, January, 1948, pp. 58–61, fig.

As the apparent contrast of a square test object situated behind a smoke layer is decreased in laboratory experiments, a point is reached at which the object appears as a light patch of unrecognizable shape. On decreasing the apparent contrast a little further, the object becomes completely invisible. A study of the conditions under which the apparent loss of definition occurs was carried on simultaneously with the study of total obscuration described in the preceding paper. The optical density of smoke required to produce loss of definition was found to be linearly related to the logarithm of the ratio of object to cloud brightness, in close correspondence with the relation found for total obscuration. Over the range of our experiments the minimum optical density of smoke associated with loss of definition was from 12 to 23 per cent less than that associated with total obscuration, the magnitude of the difference depending on brightness conditions. Since the

phenomenon of loss of definition is observable in the presence of a veiling glare without smoke, it is probably of physiological origin.

A Note on the Determination of the Extinction Coefficient of Aerosols. G. O. Langstroth and J. L. Wolfson. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 25, No. 1, January, 1947, pp. 62–67, diagrs., fig. 2 references.

Difficulties were encountered in smoke chamber experiments in obtaining reliable extinction coefficient data by methods based on brightness measurements of bright and "black" surfaces seen through the smoke. These difficulties led to an investigation of the reliability of a commonly used method employing a parallel light beam and a photoelectric cell. The results indicate that the method is capable of yielding extinction coefficient data with an accuracy of 1 to 2 per cent under the conditions of the experiments.

Mollier Diagrams for Air Saturated with Water Vapor at Low Temperatures. Reece V. Hensley. *U.S., N.A.C.A., Technical Note No. 1715*, September, 1948. 16 pp., diagrs. 3 references.

A temperature range of 400° to 540°R. and a pressure range of 2 to 28 lbs. per sq.in. absolute are covered. Vapor-liquid and vapor-solid equilibrium are treated. Examples illustrate the use of the charts in the solution of thermodynamic problems involving wet air and problems involving ice.

Drop-Size Distribution Measurements in Orographic Rain. Lloyd J. Anderson. *American Meteorological Society, Bulletin*, Vol. 29, No. 7, September, 1948, pp. 362–366, figs. 3 references.

Effects of the Ozone Shadow. R. Penndorf. *Journal of Meteorology*, Vol. 5, No. 4, August, 1948, pp. 152–160, figs. 11 references.

The radius of the earth's shadow for ultraviolet sunlight is enlarged by an amount equal to the altitude of the upper boundary of the ozone layer. This ozone shadow causes ionization in the ionosphere to be delayed after sunrise. From this delay the upper height of the ozone layer may be calculated. The vertical distribution of ozone may be determined in the variations in the intensity of ultraviolet light reflected from the moon during a lunar eclipse. The premature decay in the intensity of the sodium *D*-line at sunset is also attributed to the ozone shadow.

Constant Pressure and Differential Analysis with Practical Applications. George J. Haltiner and Max Andrews Eaton. (*NavAer 50-1R-216.*) *U.S., Navy Postgraduate School, Annapolis, Department of Aerological Engineering*, January, 1948. 51 pp., figs. 10 references.

A descriptive treatment of the techniques of constant-pressure and differential analyses and the applications of this type of upper-air analysis to forecasting. Most mathematical derivations have been eliminated to provide an elementary text suitable for the instruction of aerological personnel with limited mathematical training. The technique analyzes the atmosphere layer by layer and, through the superposition of successive layers, permits a check of the mutual consistency of the analyses of individual layers. The method is particularly advantageous over areas in which the upper-air reports are few compared with sea-level observations, in that maximum use is made of all observations.

First Partial Report on the Artificial Production of Precipitation; Stratiform Clouds—Ohio, 1948. *U.S. Weather Bureau, Research Paper No. 30*. August, 1948. 63 pp., illus., figs. 22 references.

The Experimental Micrometerological Field Installation at Manor, Texas. K. H. Jehn. *American Meteorological Society, Bulletin*, Vol. 29, No. 7, September, 1948, pp. 367–374, illus., figs.

The Symposium on Micrometeorology at Austin, Texas, March 18–19, 1948. John R. Gerhardt. *American Meteorological Society, Bulletin*, Vol. 29, No. 7, September, 1948, pp. 378–381, 4 references.

The Ocean Weather Service. P. G. Satow. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 80–84.

Determination of the Position and Path of a Hurricane, a Recent Important Seismological Contribution to Navigation. Daniel Linehan. *Navigation*, Vol. 1, No. 11, September, 1948, pp. 232–235. 4 references.

Ocean Weather Ships. *Air World*, Vol. 1, No. 4, September, 1948, pp. 94, 95, illus.

Comments on Paper by Seymour L. Hess and Harold Wagner Entitled, "On the Prognostic Usefullness of the Correlation Between Pressure and Temperature Changes at 3 km." J. Namias. *American Meteorological Society, Bulletin*, Vol. 29, No. 8, October, 1948, pp. 428–432, figs.

On the Vertical Distribution of Mean Temperature Within the Microclimatic Layer. Werner A. Baum. *American Meteorological Society, Bulletin*, Vol. 29, No. 8, October, 1948, pp. 424–428, fig.

A Technique for a Synoptic-Climatological Study of an Air Route. N. E. Manos and W. L. Molo. *American Meteorological Society, Bulletin*, Vol. 29, No. 8, October, 1948, pp. 401–407, figs.

On the General Circulation of the Atmosphere in Middle Latitudes: Southern and Northern Hemispheres Compared. H. H. Lamb. *American Meteorological Society, Bulletin*, Vol. 29, No. 8, October, 1948, pp. 391–394.

Wind Statistics and Their Application to Airline Operations. E. Brooks Williams. *Institute of Navigation (London), Journal*, Vol. 1, No. 2, April, 1948, pp. 155–160, figs.

A Preliminary Evaluation of the Use of Ground Radar for the Avoidance of Turbulent Clouds. H. Press and E. T. Binckley. *U.S., N.A.C.A., Technical Note No. 1684*, September, 1948. 13 pp., figs. 4 references.

An analysis of gust data obtained within convective-type thunderstorms and in the immediate vicinity of the storms during the 1946 operations of the U.S. Weather Bureau thunderstorm project in Florida. Appreciable reduction in the experience of turbulence can be achieved by circumnavigation of areas of radar echo as indicated by ground-radar equipment. Quantitative data indicate the reductions in turbulence experience that may be expected.

The Propagation of Permanent-Type Waves in Horizontal Flow. Philip Duncan Thompson. *Journal of Meteorology*, Vol. 4, No. 4, August, 1948, pp. 166–168. 5 references.

The Distribution of Raindrops with Size. J. S. Marshall and W. McK. Palmer. *Journal of Meteorology*, Vol. 5, No. 4, August, 1948, pp. 165, 166, figs. 3 references.

Drop Size, Intensity, and Radar Echo of Rain. Athelstan F. Spilhaus. *Journal of Meteorology*, Vol. 5, No. 4, August, 1948, pp. 161–164, figs. 8 references.

Calculation of Solar Radiation and the Solar Heat Load on Man. William H. Klein. *Journal of Meteorology*, Vol. 5, No. 4, August, 1948, pp. 119–129, figs. 39 references.

Rain Intensities by Radar. Raymond Wexler. *Journal of Meteorology*, Vol. 5, No. 4, August, 1948, pp. 171–173, figs. 8 references.

On the Concept of Frontogenesis. James E. Miller. *Journal of Meteorology*, Vol. 5, No. 4, August, 1948, pp. 169–171, figs. 3 references.

Correspondence: The Physics of Fog Formation. R. C. Sutcliffe. **Reply.** G. Emmons. *Journal of Meteorology*, Vol. 5, No. 3, June, 1948, p. 118.

Contribution to the Aerology of the Tropical Atlantic. Lauri A. Vuorela. *Journal of Meteorology*, Vol. 5, No. 3, June, 1948, pp. 115–117, figs. 6 references.

Ivory's Psychrometric Formula and the Concepts of Equivalent Temperature and Wet-Bulb Temperature. R. B. Montgomery. *Journal of Meteorology*, Vol. 5, No. 3, June, 1948, pp. 113–115. 19 references.

Insolation in Relation to Cloud Type. Bernhard Haurwitz. *Journal of Meteorology*, Vol. 5, No. 3, June, 1948, pp. 110–113, figs. 3 references.

Raindrop Size, Shape, and Falling Speed. A. F. Spilhaus. *Journal of Meteorology*, Vol. 5, No. 3, June, 1948, pp. 108–110, figs. 5 references.

A Note on Cumulus Growth in a Nonsaturated Environment. James M. Austin. *Journal of Meteorology*, Vol. 5, No. 3, June, 1948, pp. 103–107, figs. 5 references.

Helmholtz Waves in a Linear Temperature Field with Vertical Wind Shear. Z. Sekera. *Journal of Meteorology*, Vol. 5, No. 3, June, 1948, pp. 93–102, figs. 17 references.

On the Computation of Wind From Pressure Data. M. Neilburger, L. Sherman, W. W. Kellogg, and A. F. Gustafson. *Journal of Meteorology*, Vol. 5, No. 3, June, 1948, pp. 87–92, figs. 4 references.

Thunderstorm Structure and Circulation. Horace R. Byers and Roscoe R. Braham, Jr. *Journal of Meteorology*, Vol. 5, No. 3, June, 1948, pp. 71–86, illus., figs. 16 references.

Navigation (29)

Grid Navigation and Its Allied Problems. R. H. Blackmore. *Institute of Navigation (London), Journal*, Vol. 1, No. 2, April, 1948, pp. 161–170, Discussion, pp. 170–174, figs. 2 references.

Polar navigation and great-circle navigation require the use of a grid-navigation technique. The necessary correction of magnetic-compass readings can be obtained from isogrivs that correspond to isogonals on Mercator projections.

Pressure Pattern Flying. I—Elementary Theory Underlying Pressure Pattern Flying Techniques. D. O. Fraser. **II—The Navigational Value of Pressure Pattern Techniques.** L. F. Banks. **III—The Meteorological Limitations on Pressure Pattern Flying.** J. S. Sawyer. **IV—The Application of Pressure Pattern Flying to Civil Transoceanic Routes.** E. W. Pike. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 40–50; 51–55; 55–61; 62–65, figs.

The Theory and Computation of Single Heading Flights. Irving I. Gringorten. *American Meteorological Society, Bulletin*, Vol. 29, No. 7, September, 1948, pp. 343–351, diagrs., figs. 6 references.

The Navigational Aspect of Flight Refuelling. D. C. T. Bennett. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 85, 86.

Navigation in Automatic Flight. H. E. C. Boxer. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 87, 88.

The Development of Navigation. Harold Spencer Jones. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 1–10.

Air Navigation and the New Institute. John Slessor. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 11, 12.

International Civil Aviation Organization. I—Areonautical Charts. G. A. H. Harvey. **II—Report of the Cot Division.** G. M. Macintosh. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 76–79.

The Second International Meeting on Radio Aids to Marine Navigation New York and New London, 28 April–9 May (IMRAMN, 1947). R. B. Michell. *Institute of Navigation, (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 69–71, Appendix, 72–75.

What is the Ideal Air Map? Francis Chichester. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 66–68.

Altitude Corrections for Coriolis and Other Accelerations. D. H. Sadler. *Institute of Navigation (London), Journal*, Vol. 1, No. 1, January, 1948, pp. 22–28.

The Navigational Work of Nautical Almanac Office. D. H. Sadler. *Institute of Navigation (London), Journal*, Vol. 1, No. 2, April, 1948, pp. 148–153, Discussion, pp. 153, 154.

Time Determination and Time Keeping. Harold Spencer Jones. *Institute of Navigation (London), Journal*, Vol. 1, No. 2, April, 1948, pp. 109–117.

Operations

CAA Aircraft Use Survey Shows Gains Made in 1947. *CAA Journal*, Vol. 9, No. 9, September 15, 1948, pp. 97, 108.

Winter Flying. *Aircraft and Airport*, Vol. 10, No. 9, September, 1948, pp. 12–14, illus.

Airborne Magnetometer Developed for High Speed Mineral Surveys. J. M. Bridgeman. *Canadian Aviation*, Vol. 21, No. 10, October, 1948, pp. 22, 23, 46, illus.

Flying Magnetometer Speeds Oil Search. Irving Stone. *Aviation Week*, Vol. 49, No. 8, August 23, 1948, pp. 25, 26, illus.

Airborne Oil Prospectors. *The Pegasus*, October, 1948, pp. 12–16, illus.

How New Flying Magnetometer Speeds Search for Oil. *Airports & Air Carriers*, Vol. 14, No. 3, September, 1948, pp. 22, 23, 32, illus.

Planes Versus Fires. *Aircraft and Airport*, Vol. 10, No. 8, August, 1948, pp. 16, 17, illus.

COMMERCIAL (41)

Some Economic Problems of the Air Transport Industry. W. L. McMillen. *S.A.E. National Aeronautic Meeting, Los Angeles, October 6–9, 1948, Preprint.* 15 pp., fig.

In spite of the general downward trend of the operating costs of the air-transport industry and considerable reductions in the break-even load factor, the financial condition of the industry is not improving. This condition exists because of excessive competition among the scheduled air lines, the additional competition of the nonscheduled lines over the most profitable routes, the multiplication of route mileage to strengthen weak air lines without sufficient regard for the traffic potential and existing service on the additional mileage, and the existing policy of subsidy for inefficient lines rather than their merger into efficient economic units.

Economics Through Standardization. William Littlewood. *SAE Journal;* Vol. 56, No. 9, September, 1948, pp. 41–43. (Extended summary of a paper: Standardization and Simplification for the Air Transport Industry.)

National Transportation Policy. John H. Frederick. *Distribution Age*, Vol. 47, No. 8, August, 1948, pp. 42, 53, 64, 65, illus.

Air Transport Problems. E. S. Land. *SAE Journal*, Vol. 56, No. 10, October, 1948, pp. 25–27. (Extended summary of a paper.)

Volume Business Through Air Freight. W. F. Rogers. *Air Transportation*, Vol. 13, No. 2, August, 1948, pp. 16, 17, 38, illus.

Dependable Service Sells the Shipper and Consignee. Walter Sternberg. *Air Transportation*, Vol. 13, No. 3, September, 1948, pp. 15, 36.

Your Market Place is in the Air. R. E. Whitmer. *Air Transportation*, Vol. 13, No. 2, August, 1948, pp. 8–11, 41, illus.

Aircargo and the Feeders. Michael E. Cole. *Distribution Age*, Vol. 47, No. 8, August, 1948, pp. 50, 51, 55.

The Contract Carriers. John H. Frederick. *Distribution Age*, Vol. 47, No. 9, September, 1948, pp. 38, 49, 56, 57.

CAB Cautious on Feeder Future. Charles Adams. *Aviation Week*, Vol. 49, No. 11, September 13, 1948, pp. 39, 40.

Stop Giving $10,000,000 Away! Tom Haire. *Airports & Air Carriers*, Vol. 14, No. 3, September, 1948, pp. 6–9, illus., tables. Air-line food costs.

Delta Supply Costs Up 25 Per Cent. *Aviation Week*, Vol. 49, No. 9, August 30, 1948, pp. 40, 41. With table showing kind and value of purchases during 1947.

Intelex, Automatic Reservations. J. D. Mountain and E. M. S. McWhirter. *Electrical Communication*, Vol. 25, No. 3, September, 1948, pp. 220–231, illus., diagrs. The application of Intelex, an automatic electronic and electromechanical system, to typical air-line reservation problems, and a comparison of its features with those of reservation methods in current use.

Preparing for Service. I. *The Aeroplane*, Vol. 75, No. 1946, September 24, 1948, pp. 426, 427, illus. Development trials and preparations that must be made by air lines when putting new aircraft into service.

Newer Planes Mean Fewer Pilots. Charles Adams. *Aviation Week*, Vol. 49, No. 14, October 4, 1948, pp. 31, 32. The effect of the acquisition of larger and faster aircraft by the air lines on the employment of operating personnel.

Hurry-Up Service at Idlewild (Federal Inspection Services). James A. Buckley. *Air Transportation*, Vol. 13, No. 2, August, 1948, pp. 20–22, 43, illus.

New Aerial Supply System Developed. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 18, September 15, 1948, p. 4.

Airlines Backstop Berlin Airlift. *Aviation Week*, Vol. 49, No. 12, September 20, 1948, pp. 63, 64, illus.

Where Stand Our Airlines? E. T. House. *Aeronautics*, Vol. 19, No. 4, September, 1948, pp. 70–78, maps, charts. A detailed summary of the operating economics of British air-line corporations, and comparisons with the air lines of other countries.

Operating and Traffic Statistics of the U. K. Airways Corporations, 1947–8. *Indian Aviation*, Vol. 32, No. 8, August, 1948, pp. 246, 248.

B.O.A.C. Plans and Reorganization. *Flight*, Vol. 54, No. 2066, July 29, 1948, pp. 115–117, illus., figs.

Air Services in Britain; 1939–1948: A Comparison. *Modern Transport*, Vol. 59, No. 1533, August 14, 1948, p. 11.

Airline Traffic Organisation and Development with Special Reference to Scotland. J. W. Swann. *Institute of Transport, Journal*, Vol. 22, No. 19, June-July, 1948, pp. 686–689.

Progress of Civil Aviation in India; Increased Traffic and More Frequent Services. *Indian Aviation*, Vol. 32, No. 6, June, 1948, pp. 166–170, 187, 188.

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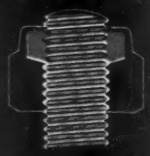

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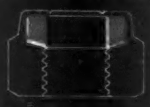

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The New Air France. *The Aeroplane*, Vol. 75, No. 1941, August 20, 1948, pp. 224, 225, illus.

Know Your Airlines. XI—This is TAA (Trans-Australia Airlines). Stanley Brogden. *Aircraft*, Vol. 26, No. 11, August, 1948, pp. 12–17, 40–42, 44, 46, illus.

25 Years of Finnish Air Lines. *Air World*, Vol. 1, No. 4, September, 1948, pp. 88, 89, illus.

Air Transport in Eastern Europe; Traffic from Prague. *Modern Transport*, Vol. 54, No. 1535, August 28, 1948, p. 15, table.

MILITARY (24)

B.E.A. to Berlin. I—Scheduled Services and the Civil Air Lift; Methods and Results. H. F. King. *Flight*, Vol. 54, No. 2075, September 30, 1948, pp. 393–395, illus.

Air Lift Breaks the Berlin Blockade. Michael H. Froelich. *Flying*, Vol. 43, No. 4, October, 1948, pp. 23–25, 76, illus.

Operation Vittles (Berlin Air Lift). *Air Transportation*, Vol. 13, No. 2, August, 1948, pp. 18, 19, 40, illus.

F-80's Across (the Atlantic). Jack Powell. *Aero Digest*, Vol. 57, No. 3, September, 1948, pp. 34, 35, 144–146, illus.

Airborne Warfare. James M. Gavin. *Ordnance*, Vol. 33, No. 170, September-October, 1948, Section 1, pp. 106–108, illus.

Ordnance & Armament (22)

The Testing of Range Finders. Irvine C. Gardner. *Journal of Applied Physics*, Vol. 19, No. 8, August, 1948, pp. 729–738, figs.

A Range-Finder Testing Laboratory. Irvine C. Gardner. *Journal of Applied Physics*, Vol. 19, No. 8, August, 1948, pp. 721–728, illus., figs.

Research Work of the Franklin Institute During World War II on Airborne Fire Control Apparatus. Ralph H. McClarren. *Franklin Institute, Journal*, Vol. 246, No. 4, October, 1948, pp. 273–291, illus., diagr.

Ordnance Electronics; New Concepts in the Art of Fire Control. Donald A. Quarles. *Ordnance*, Vol. 33, No. 170, September-October, 1948, Section 1, pp. 93–95, illus.

Ground-to-Air Defense; Antiaircraft Artillery Has an Assured Place in America's Forces. Preston R. Bassett. *Ordnance*, Vol. 33, No. 170, September-October, 1948, Section 1, pp. 99–101, illus.

The Use of Flat-Ended Projectiles for Determining Dynamic Yield Stress. I—Theoretical Considerations. Goeffrey Taylor. **II—Tests on Various Metallic Materials.** A. C. Whiffin. **III—Changes in Microstructure Caused by Deformation Under Impact at High-Striking Velocities.** W. E. Carrington and Marie L. V. Gayler. *Royal Society of London, Proceedings, Series A*, Vol. 194, No. 1038, September 2, 1948, pp. 289–299; 300–322; 323–330; illus., diagrs., figs., 8 pp. of illus. 1, 1, 6 references.

A New Saab Invention; Self-Marking Target by Aircraft. *Saab Sonics*, No. 3, July–September, 1948, pp. 14, 15, figs.

Parachutes*

Theory of the Flat Elastic Parachute. W. J. Duncan, G. W. H. Stevens, and G. J. Richards. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2118*, March, 1942. 18 pp., figs. 4 references. British Information Services, New York. $1.15.

A flat parachute has a simplified type of canopy that, when unloaded, can be developed into a plane sheet. The behavior under load of such canopies depends largely on the elasticity of the fabric. It is assumed that the canopy near the crown is a surface of revolution up to a critical radius where the circumferential tension vanishes; beyond this radius, small regular wrinkles are assumed, and the shape conforms to that of the Taylor parachute. In practice, canopies usually fail at places where the stress is concentrated, such as near rigging line attachments, but stress concentrations can be reduced by good design. However, the tensile stress at the crown determines an upper bound to the load-carrying capacity of the canopy. When the greatest permissible stretch is extremely small, the permissible load is proportional to the fourth root of this stretch.

The Cause of the Spontaneous Opening and Closing of Parachutes (The Phenomena of "Squidding"). W. J. Duncan. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2119*, December, 1943. 9 pp., illus., figs. 4 references. British Information Services, New York. $0.70.

It is observed that an open parachute with a porous canopy will collapse to what has been called the "squid shape" at a critical value of the relative air speed and that, if the relative air speed is thereafter reduced, the collapsed canopy will reopen at a second (lower) critical speed. These phenomena are attributed to a characteristic of woven parachute fabrics which is believed to be universal—namely, the increase of the effective permeability of the fabric with increasing pressure difference or relative air speed. Because of this, the ratio of the mean axial velocity through the mouth of the canopy to the velocity of the canopy relative to the undisturbed air increases with the latter, and the angle of incidence of the resultant air current on the lip of the canopy concurrently decreases. Ultimately, the incidence changes sign and the canopy then collapses. This explanation covers the facts that the critical speeds for squidding increase as the shroud lines are lengthened and as the porosity of the canopy is reduced.

The Multi Channel Recorder. W. C. Buhler, H. F. Freeman, and C. L. Saunders. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 16, August 15, 1948, pp. 11–15, illus., figs.

An air-borne magnetic-tape recording unit developed by the A.M.C. and Cook Research Laboratories to obtain parachute operational data. The unit can withstand forces of 75*g* and records simultaneously the magnitude and duration of opening shock acceleration along three mutually perpendicular axes; the total drag developed by the canopy during inflation versus time; altitude versus time during the inflated descent; the angular displacement of the centerline of the parachute gondola versus time from the instant of release until complete inflation; altitude and time of opening of parachute; and landing shock accelerations along three mutually perpendicular axes. A playback unit reproduces the recorded data in the form of graphs.

Personal Flying (42)

Single Engine on Instruments. Arthur K. Baker. *Air Facts*, Vol. 11, No. 10, October 1, 1948, pp. 22–24, 26.

Sales Aids for Business Planes. *Airports & Air Carriers*, Vol. 14, No. 3, September, 1948, p. 27, illus.

Planning a Foreign Flight? Richard J. Aubry. *Air Facts*, Vol. 11, No. 9, September 1, 1948, pp. 58–66.

Personnel (37)

Technical Education (at Saab's Technical Training School). Anders Widengren. *Saab Sonics*, No. 3, July–September, 1948, pp. 4–7, illus.

Advanced Training in TF-80. V. Noriega. *Plane Facts*, Vol. 5, No. 8, August, 1948, pp. 20, 21, 28, illus.

Photography (26)

Choosing an Emulsion and Processing Technique for Daylight Aerial Photography. L. E. Howlett. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 26, No. 2, March, 1948, pp. 60–63, figs.

Experiments are reported that show the relations existing between gamma, useful exposure range for aerial photography, maximum resolving power, and emulsion speed as determined by the resolving power criterion. Aero Super XX and Panatomic X, processed in various ways, were used for the experiments. The results are used to deduce the proper choice of emulsion and processing technique for ordinary daylight aerial photography where the main requirement is the acquisition of information.

A Stabilized Camera Mount in Aircraft. A. D. Keogh. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 19, October 1, 1948, pp. 13–19, illus., diagrs.

A gyrostabilized aerial-camera mount that will maintain a selected position within 6 min. of zero when the disturbing force is no greater than a rotational motion corresponding to 3° of arc per sec. The erecting mechanism of the gyroscope is controlled by the shifting of a bubble in an electrolyte. Shifting of the bubble upsets the balance in a resistance bridge circuit through four contacts at the surface of the liquid. A light source, mirror takeoff, and photocell system transmits the gyroscope corrections to

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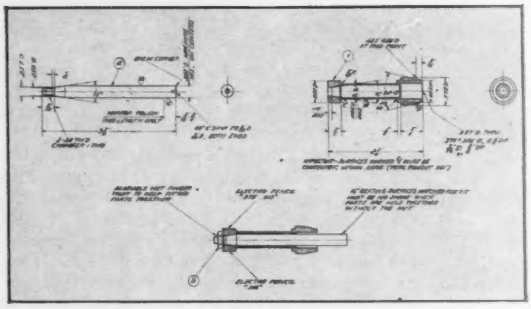

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high-speed rapid-reversal electric motors that maintain the camera in a fixed relation to the vertical axis of the gyroscope.

Flying Prospectors. R. Russell. *The Aeroplane*, Vol. 75, No. 1942, August 27, 1948, pp. 248–250, illus.

The Airman's View of the World. J. H. Saffery. *Air World*, Vol. 1, No. 4, September, 1948, pp. 90–92, illus.

New Aerial "Eye" Has Ten-Mile Sight (Eastman Kodak). *Aviation Week*, Vol. 49, No. 15, October 11, 1948, p. 30, illus.

Power Plants

Determination of Optimum Airplane-Powerplant Combination. J. H. Brewster, III. *SAE Journal*, Vol. 56, No. 10, October, 1948, pp. 32–36, figs. (Extended summary of a paper.)

A system of nondimensional aerodynamic variables eliminates size and other troublesome factors. The method gives a first approximation to the airplane-engine combination that has the lowest take-off gross weight for any given set of performance specifications without laborious studies and analyses of the performance possibilities of whole families of airplanes of different sizes, various wing loadings, power loadings, and aspect ratios. One can determine specifically such items as the best type of power plant, the approximate horsepower or thrust required, the approximate size and gross weight, optimum characteristics of the airplane, and the limiting cruising speed beyond which it is uneconomical to go for any given range and altitude.

Power Plant Problems of CAA Certification. Gaylord W. Newton. *S.A.E. National Aeronautic Meeting, Los Angeles, October 6–9, 1948, Preprint.* 6 pp.

Britain's Power Units. *Flight*, Vol. 54, No. 2071, September 2, 1948, pp. 268–273, illus. Descriptions of twelve gas turbines and 16 reciprocating engines.

Power-Plant Production in Sweden; Brief Survey of the Work of Svenska Flygmotor AB. *Flight*, Vol. 54, No. 2069, August, 19, 1948, pp. 216, 217, illus., diagrs.

The Art of the Aviation Engine. F. R. Banks. *Royal Aeronautical Society, Journal*, Vol. 52, No. 453, September, 1948, pp. 527–550. (*See* AER 8/48:67.)

JET & TURBINE (5)

Jet Propulsion Can be Efficient at Low Speeds. Henry C. Hill. *Automotive Industries*, Vol. 99, No. 6, September 15, 1948, pp. 46–48, 70, 74, figs.

The relatively high propulsive efficiency of jet aircraft when compared with reciprocating-engined aircraft at high speeds is caused not by the increased thrust or the decreased specific fuel consumption of the turbojet but by the increasingly poor performance of the propeller at these speeds. An analysis of the thermodynamics of the turbojet engine shows that a high jet velocity, if accompanied by sufficiently high thermal efficiency, is more efficient than a low jet velocity. If current trends toward improved thermal efficiency of the gas-turbine cycle are successful, the aircraft jet engine will eventually out-perform the propeller-driven engine in all categories.

Enthalpy-Entropy Diagram (Combustion Gas-Kerosene). Heinrich Reindorf. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 17, September 1, 1948, pp. 11–17.

A diagram that contains only one curve of constant pressure for each fuel-air ratio. The enthalpy of the products of combustion of 1 lb. of air and the amount of fuel burned therein can be read directly. Below 3,500°R., the amount of fuel required for an assumed temperature rise can be determined rapidly.

Analytical and Experimental Performance of an Explosion-Cycle Combustion Chamber for a Jet-Propulsion Engine. Morris A. Zipkin and George W. Lewis, Jr. *U.S., N.A.C.A., Technical Note No. 1702*, September, 1948, 59 pp., illus., diagrs., figs. 5 references.

Calculated and experimentally determined explosion-pressure ratio, thrust, and specific fuel consumption obtained in a combustion chamber with a timed inlet valve and several fixed-area nozzles are presented over a range of fuel-air ratios. The effects of variations in cycle frequency and inlet pressures were investigated. Maximum experimental values of explosion-pressure ratio and jet thrust were approximately 2.9 and 35 lbs. per lb. of air per sec., respectively, and occurred at an overall fuel-air ratio of about 0.04.

Analysis of the Performance of a Jet Engine from Characteristics of the Components. II—Interaction of the Components as Determined from Engine Operation. Arthur W. Goldstein, Sumner Alpert, William Beede, and Karl Kovach. *U.S., N.A.C.A., Technical Note No. 1701*, September, 1948. 56 pp., illus., diagrs., figs. 9 references.

A method of analyzing turbojet engine compressor and turbine interaction was developed and used to evaluate applicability data from cold-air investigations of turbine component to predict engine performance, to predict performance of modified engine, to determine engine and component operation as a hot-gas generator for a power turbine, to determine performance of complete turbine-propeller engine, and to explain some phenomena of turbojet engine operation.

Method of Matching Performance of Compressor Systems with That of Aircraft Power Sections. Robert O. Bullock, Robert C. Keetch, and Jason J. Moses. *U.S., N.A.C.A., Report No. 815*, 1945. 7 pp., figs. 2 references. U.S. Govt. Printing Office, Washington. $0.15.

Effect of Pressure Recovery on the Performance of a Jet-Propelled Airplane. Frederick H. Hanson, Jr., and Emmet A. Mossman. *U.S., N.A.C.A., Technical Note No. 1695*, September, 1948. 35 pp., figs. 6 references.

The effect of ram-recovery ratio on the net thrust and on the specific fuel consumption of a turbojet engine was calculated for various speeds and for altitudes from sea level to 40,000 ft. in order to evaluate the importance of the pressure-recovery efficiency of the air-intake system and to determine the effect of this efficiency on the performance of a typical jet-propelled airplane. At a velocity of 650 m.p.h. at sea level, an increase in ram-recovery ratio from 0.70 to 0.90 resulted in an 18.9 per cent increase in net thrust and a 9.5 per cent decrease in specific fuel consumption. The performance analysis indicated that the attainment of high ram recovery should be given major consideration in power plane design and will become of greater importance in obtaining optimum performance as airplanes are developed which have higher drag-divergence Mach Numbers and utilize more powerful jet engines.

Thermodynamic Properties of Combustion Gases. J. Kestin. *Aircraft Engineering*, Vol. 20, No. 234, August, 1948, pp. 234–242, figs.

All the calculations required to determine the efficiency of a gas turbine are related to the properties of air. Each calculation requires the determination of one constant that depends on the molar composition of the combustion gas. The difference between the property of the combustion gas and the corresponding value for air at the same temperature is a function of this constant only. A set of corrections may then be established for the molar specific heat at constant pressure, the molar enthalpy, and the molar entropy function that depends only on the temperature. The corrections are given in tabular and graphic form.

Isothermal Expansion in Nozzles. *American Rocket Society, Journal*, No. 74, June, 1948, pp. 71–73, figs.

By maintaining constant the temperature of gases expanding in a jet nozzle, substantially higher jet velocities could be obtained. In rocket design this would permit a reduction in mass ratio. Isothermal expansion would require a shorter combustion chamber and a coarser mixing so that fuel and oxidizer, which would enter the nozzle with combustion still incomplete, would continue reacting all the way through the nozzle.

Effect of More Powerful Power Plants on the Flight Performance of Turbo-Jet Fighters. Huber. (*B.M.W. Flugmotorenbau G.m.b.H., EZS-B43*, April 12, 1944.) *U.S., Air Force, Translation No. F-TS-1569-RE (ATI No. 19201)*, September, 1948. 10 pp., figs.

The Me 262 jet fighter was used as a basis to obtain data for possible increase of performance. Tests were also extended to an all-wing airplane under equal conditions—i.e., equal weights and fuel loads. Results showed that flight performance in the Me 262 had improved. When doubling the turbojet thrust, the speed of Me 262 increases about 180 km. per hour at sea level; at 11-km. altitude, the speed increases about 90 km. per hour. The speed of the all-wing aircraft was still higher.

Spray Angle Indicator Developed for Gas Turbine Fuel Nozzles. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 17, September 1, 1948, pp. 7, 8.

The Next Step—Afterburning. D. J. Jordan. *S.A.E. National Aeronautical Meeting, Los Angeles, October 6–9, 1948, Preprint.* 6 pp., figs.

A comparison of the performance of a turbojet engine with and without afterburning. The higher maximum thrust per unit frontal area which is obtained with afterburning will probably make the turbojet with afterburning the optimum power plant for aircraft that are designed to operate at high maximum speeds for short periods.

Automatic Control of Turbo-Jet Engines. Clifford S. Cody. *American Society of Mechanical Engineers, Aviation Conference, Dayton, O., September 20–21, 1948, Paper No. 48-AV-3.* 20 pp., diagr., figs. 1 reference.

A survey based on operational experience and design studies of the fuel control, acceleration control, mechanical requirements, and variable-area exhaust-nozzle controls. A single-lever control giving as linear relationship between thrust and throttle movement should hold the selected thrust stable within specified limits for each flight speed and altitude. Basic design should be based on direct measurements rather than on scheduling. Engine acceleration should be as rapid as the temperature and aerodynamic limitations of the engine permit. A fast response rate should provide for rapid changes in the operating loads. Control elements should give a low fuel-pressure drop and should operate satisfactorily on contaminated fuel.

Pressure Recovery Ups Jet Output. Robert McLarren. *Aviation Week*, Vol. 49, No. 14, October 4, 1948, pp. 18, 21, figs. 4 references.

Flight tests have confirmed the appropriateness of the ratio of the total pressure at the compressor inlet to the total pressure of the free stream as a parameter by which to evaluate the efficiency of the inlet-air ducting system of turbojet engines. A high pressure-recovery rating improved the performance of aircraft by decreasing the fuel consumption and by increasing the thrust, rate of climb, and range.

The Control of Structural Temperature in Jet-Propelled Aircraft. G. F. Anisman and M. W. Blackstone. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 677–684, illus., diagrs., figs. 6 references.

The test equipment and methods used to obtain measurements of the structural temperatures of a fuselage in the vicinity of a jet-engine tailpipe insulated with amosite, with radiation shielding, and with a leached fiberglas blanket. The handling properties of the leached fiberglas insulation were excellent and its insulative properties resulted in lower cooling airflow requirements than either of the other two installations. Analysis of the heat-transfer processes that occurred indicated that, of the total heat transfer through the insulation, 1 to 7 per cent was by radiation. The remainder was by forced convection. Of the total heat input, 2 to 7 per cent was lost by free convection and radiation from outside the fuselage. The remainder was carried away by the cooling air. The fuselage frame supporting the aft trunnion fitting was the most critical insofar as cooling was concerned. The cooling airflow requirements used were those required to keep the temperature of the frame at 200°F.

Supersonic Role Awaits Turbojet. *Aviation Week*, Vol. 49, No. 9, August 30, 1948, pp. 28–30, fig. 3 references.

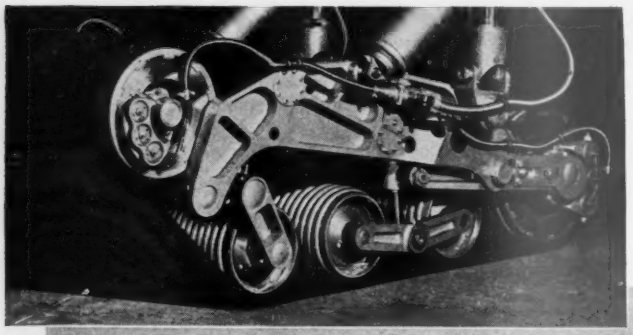
A discussion of the inlet contraction ratio, entrance and exit cone angles and diffusers of turbojet engines designed to operate at velocities between Mach 1 and Mach 2. The limitations of turbine inlet temperature will seriously limit the thrust available in this range, but the specific fuel consumption will be improved. The restriction of turbine inlet temperature can be overcome by using a ram-jet afterburner with a turbojet and retain the high-speed efficiency of the ram-jet without foregoing the subsonic efficiency of the turbojet.

Turbojet Operated with "Cold" Blades. *Aviation Week*, Vol. 49, No. 15, October 11, 1948, pp. 28, 29.

A turbojet burner designed by Skyhawk Motors, Inc., is claimed to reduce the pressure loss between compressor and turbine and to develop high thrust without subjecting turbine blades to extreme temperatures. Upon ignition at 4,000 r.p.m. the turbine blades glowed cherry red, but at 8,000 r.p.m. they cooled sufficiently to turn black. No heat colors were observed at speeds as high as 24,000 r.p.m.

Problems in the Application of Turbojet Engines to Air Transport. D. Gerdan. *S.A.E. National Aeronautic Meeting, Los Angeles, October 6–9, 1948. Preprint.* 7 pp., figs. 4 references.

How Gas Turbines Fit Into Future Power Patterns. S. A. Tucker. *Mechanical Engineering*, Vol. 70, No. 10, October, 1948, pp. 769–802.



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Design of Turbojet Installations. I. D. J. Jordan. *Aero Digest*, Vol. 57, No. 4, October, 1948, pp. 74, 76, 78, 80, 119, figs. A discussion of the basic requirements of designs for inlet and exhaust ducts of turbojet engines, tailpipe mountings, fuel-supply systems, fuel-transfer systems, and fuel-tank venting.

Exhaust-Stack Nozzle Area and Shape for Individual Cylinder Exhaust-Gas Jet-Propulsion System. Benjamin Pinkel, L. Richard Turner, Fred Voss, and Leroy V. Humble. *U.S., N.A.C.A., Report No. 765*, 1943. 25 pp., figs. 4 references. U.S. Govt. Printing Office, Washington. $0.20.

Jet Diffuser for Simulating Ram-Pressure and Altitude Conditions on a Turbojet-Engine Static Test Stand. Robert H. Essig, H. R. Bohanon, and David S. Gabriel. *U.S., N.A.C.A., Technical Note No. 1687*, August, 1948. 34 pp., illus., diagrs., figs. 1 reference.

With a jet diffuser developed to simulate ram-pressure and altitude conditions on a turbojet-engine static test stand, a maximum simulated ram-pressure ratio (engine-inlet to exhaust-chamber pressure ratio) of about 2.4 was obtained at a simulated pressure altitude of approximately 23,000 ft. Part of the pressure rise between the exhust chamber and the atmosphere occurred between the exhaust chamber and the diffuser-throat outlet. This pressure rise was in good agreement with a theoretical analysis. The existence of an optimum diffuser-throat area—the area ratio of which depends upon the ratio of jet thrust to the product of the ratio of specific heats of the exhaust gas, exhaust-chamber ambient pressure, and engine-exhaust-nozzle outlet area—was confirmed by experimental data for diffuser-throat diameters of $13^1/_2$ and 14 in. The good agreement of data obtained with and without the jet diffuser at a ram-pressure ratio of 1.0 indicated that the diffuser did not interfere with the flow through the engine exhaust nozzle at this ram-pressure ratio. The small pressure gradients measured in the exhaust chamber indicated that the diffuser had no effect on jet thrust at high ram-pressure ratios.

Fuel Pumps for Gas Turbines; Successful 500 Hour Non-Stop Test Run Made on Petrol (with Dowty Type 260Y Mark IV Fuel Pump). *Flight*, Vol. 54, No. 2075, September, 30, 1948, p. 411, cutaway drawing.

Testing Turbine Wheels. *Aero Digest*, Vol. 57, No. 2, August, 1948, p. 57, illus. The use of high-speed photography to observe the disintegration of experimental turbine rotors at high speeds and elevated temperatures at the Boeing propulsion laboratories.

Turbine Blades That Resist Heat. Harold Woodhouse. *Aero Digest*, Vol. 57, No. 2, August, 1948, pp. 74, 76, 117, figs. A survey of the alloys that have been developed for high-temperature applications and their operational limits; turbine-blade cooling by gases, liquids, and metallic salts; and the development of high-temperature ceramic coatings.

Development of Governors for Turbojet Engine. Moellmann. (*Kobue Sondertriebwerke*, September 8, 1944.) *U.S., Air Force, Translation No. F-TS-2465-RE (ATI No. 18765)*, July, 1948. 7 pp.

A discussion of control systems for turbojet engines. The reasons are given which dictated the choice of a system for the control of the fuel supply by the engine r.p.m. in the Jumo turbojet engines. Performance of the system is evaluated.

Rotating Disks in the Region of Permanent Deformation. F. László. (*Zeitschrift für Angewandte Mathematik und Mechanik, Ingenieurwissenschaftliche Forschungsarbeiten*, Vol. 5, No. 4, August, 1925, pp. 281–293.) *U.S., N.A.C.A., Technical Memorandum No. 1192*, August, 1948. 27 pp., figs. 6 references.

An investigation of the stress-strain relations in a disc under centrifugal loading. The plastic deformation of the disc under this loading can be either stable or unstable depending on whether or not the work-hardening produced by the deformation is greater than the increased tangential stress caused by the angular velocity of the deformed body. The limits of these two regions can be determined from the stress-strain curves of the material. Spinning discs to produce work-hardening is proposed as a method of fixing the dimensional stability of rotating machine elements.

A Review of Aircraft Lubrication. E. E. Turner. *The Technical Instructor*, Vol. 3, No. 8, August, 1948, pp. 3–11, 14–17, diagrs.

Turbine Engine Blading: Manufacturing Technique and Fastening Methods. A. T. Colwell and R. E. Cummings. *SAE Quarterly Transactions*, Vol. 2, No. 3, July, 1948, pp. 419–433, illus., diagrs., figs.

British and American practice in the manufacture of buckets, blades, and vanes by wide-limit forging or precision forging and finishing operations, by investment casting, and by machining from bar; and methods of inspection and quality control. The principal German, British, and American methods of attaching the blade are described. Precision is increasing in all three methods of manufacture, and all will probably be used in the future. The British method of attaching the bucket by loose-fit, fir-tree root appears to be the best all-around method developed to date.

The Application of Deep Drawing and Pressing to Gas Turbine Engines. H. E. Lardge. *Sheet Metal Industries*, Vol. 25, No. 256, August, 1948, pp. 1603–1608, illus., figs.

A description of the components of the combustion systems of the Rolls Royce jet engines Welland, Derwent I, Nene, and Derwent V, which were fabricated by deep drawing or pressing. These techniques were employed more extensively with successive engine models.

Inspecting Turbine Blades; New Electrical Equipment; Light-Signal and Dial Indications. *Aircraft Production*, Vol. 10, No. 120, October, 1948, pp. 354, 355, illus.

Turbine-Blade Inspection; Production Gauging by Optical Projection. S. G. Poulsen. *Aircraft Production*, Vol. 10, No. 119, September, 1948, pp. 291–294, illus., diagrs.

Application of Elastic Packaging to the Turbo-Jet Aircraft Engine. *Edo Corporation, Report No. 2601*, June 25, 1948. 16 pp., illus., figs. An aluminum-alloy shipping container to protect turbojet engines from corrosion and rough handling during storage and transit.

Power House. *Aircraft and Airport*, Vol. 10, No. 9, September, 1948, p. 34, illus. Packard Motor Car Co. powerplant research center.

Test Turbines Near 100,000 Rpm; Boeing Constructs Steel Pits to Study Effects on Blades of High Speed and Temperatures up to 1750 F. *Aviation Week*, Vol. 49, No. 14, October 4, 1948, p. 21, illus.

Gas Turbine. *Flight*, Vol. 54, No. 2071, September 2, 1948, p. 279. A table of specifications and performance of 16 engines.

Compound Engine. *Aero Digest*, Vol. 57, No. 3, September, 1948, p. 65, illus., diagr. A review of current designs.

Canada's First Aircraft Jet Engine, The "Chinook" (Avro). *Aero Digest*, Vol. 57, No. 3, September, 1948, pp. 106, 107, illus.

Bristol Developments. *Aircraft and Airport*, Vol. 10, No. 9, September, 1948, pp. 26–28, cutaway drawing.

Bristol Propeller Turbine Progress. *Modern Transport*, Vol. 59, No. 1533, August 14, 1948, p. 14, illus.

"Theseus" 500 Hour Test (Bristol). *Shell Aviation News*, No. 122, August, 1948, p. 23, illus.

The Napier Naiad. *The Aeroplane*, Vol. 75, No. 1940, August 13, 1948, pp. 191–195, illus., diagrs., cutaway drawing.

Napier Naiad; Novel Design Features Embodied in the Most Recent of British Airscrew-Turbines. *Flight*, Vol. 54, No. 2068, August 12, 1948, pp. 180–185, illus., diagrs., figs., cutaway drawings.

Inside the Nene (Rolls-Royce Turbojet). D. M. Desoutter. *Aeronautics*, Vol. 19, No. 4, September, 1948, pp. 95–100, diagrs., colored cutaway drawings.

Westinghouse Series of Gas Turbines. Leslie E. Neville. *Shell Aviation News*, No. 121, July, 1948, pp. 22, 23, illus.

Descriptions of Models 19A, 19B, 19XB, and 24C. They employ axial-flow compressors with circular-arc airfoil rotor blades. All but the 19A have annular combustion chambers. The combustion chamber of the 19A is of cellular construction.

RECIPROCATING (6)

Definitions and Symbols for Internal Combustion Engines. L. Richter. (*Maschinenbau und Wärmewirtschaft*, Vol. 2, No. 7–9, July–September, 1948, pp. 103–107.) *The Engineers' Digest*, Vol. 5, No. 5, August, 1948, pp. 298, 299, fig.

Internal Power, Frictional Power, and Mechanical Efficiencies of Internal Combustion Engines. L. Richter. (*Maschinenbau und Wärmewirtschaft*, Vol. 2, No. 10–12, October–December, 1947, pp. 148–153.) *The Engineers' Digest*, Vol. 5, No. 6, August, 1948, pp. 277, 278, figs.

Calculations of Economy of 18-Cylinder Radial Aircraft Engine with Exhaust-Gas Turbine Geared to the Crankshaft. Richard W. Hannum and Richard H. Zimmerman. *U.S., N.A.C.A., Report No. 822*, 1945. 9 pp., figs. 1 reference. U.S. Govt. Printing Office, Washington. $0.15.

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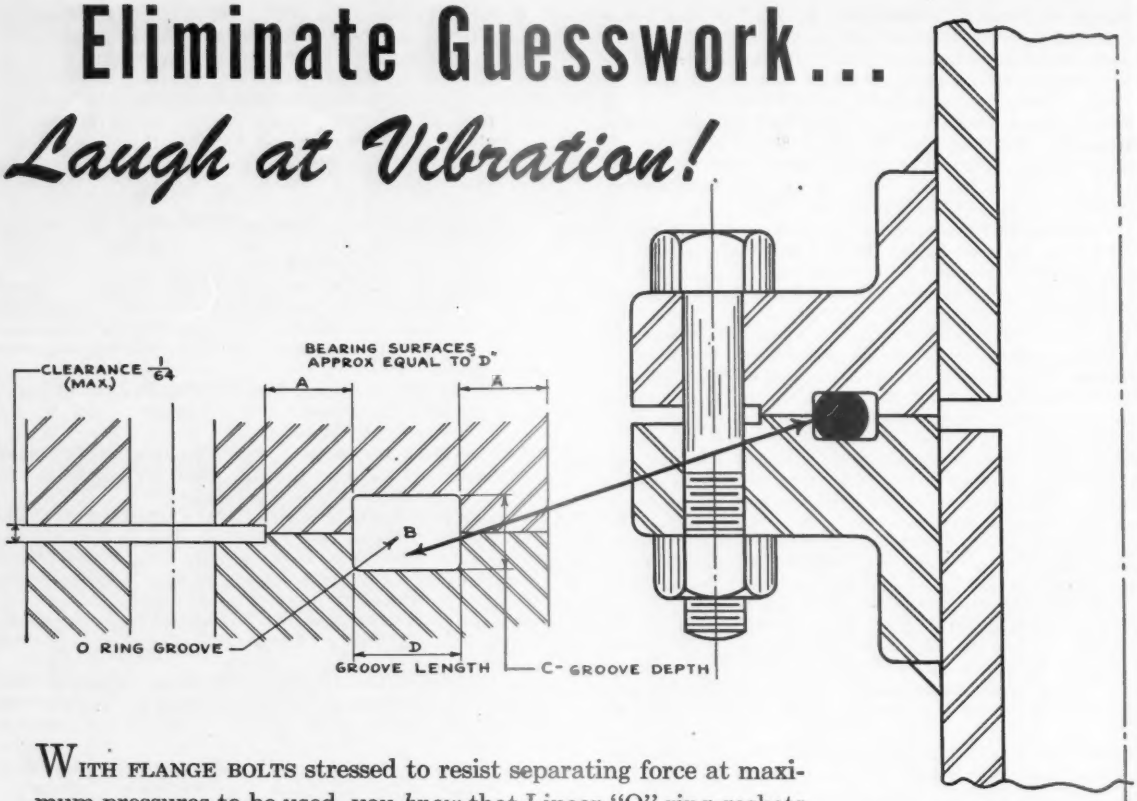

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Preignition Traced to Three Sources. A. Hundere and J. A. Bert. *SAE Journal*, Vol. 56, No. 8, August, 1948, pp. 43–45, figs. (Extended summary of a paper: Preignition and its Deleterious Effects in Aircraft Engines.)

Control of Multistage Axial Superchargers. B. Eckert. (*Stuttgart, Technische Hochschule, ZWB/FB/1425*, July 18, 1941.) *U.S., Air Force, Translation No. F-TS-2709-RE (ATI No. 23100)*, July, 1948. 5 pp., diagrs.

Design and calculations for a multistage axial-flow supercharger that can be adjusted to the rated condition under various operating conditions by connecting and disconnecting the individual stages. The design is applicable to superchargers with rotors rotating in like or opposite directions.

Effect of NACA Injection Impeller on Mixture Distribution of Double-Row Radial Aircraft Engine. Frank E. Marble, William K. Ritter, and Mahlon A. Miller. *U.S., N.A.C.A., Report No. 821*, 1945. 10 pp., illus., diagrs., figs. 4 references. U.S. Govt. Printing Office, Washington. $0.15.

Compressibility and Heating Effects on Pressure Loss and Cooling of a Baffled Cylinder Barrell. Arthur W. Goldstein and Herman H. Ellerbrock, Jr. *U.S., N.A.C.A., Report No. 783*, 1944. 22 pp., figs. U.S. Govt. Printing Office, Washington. $0.20.

Air-Consumption Parameters for Automatic Mixture Control of Aircraft Engines. Sidney J. Shames. *U.S., N.A.C.A., Report No. 804*, 1945. 6 pp., figs. 4 references. U.S. Govt. Printing Office, Washington. $0.10.

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Correlation of Exhaust-Valve Temperatures with Engine Operating Conditions and Valve Design in an Air-Cooled Cylinder. M. A. Zipkin and J. C. Sanders. *U.S., N.A.C.A., Report No. 813*, 1945. 9 pp., diagrs., figs. 5 references. U.S. Govt. Printing Office, Washington. $0.15.

Pressure Indicating for Internal Combustion Engines. I, II, III. R. Stansfield and J. G. Withers. *The Engineer*, Vol. 186, Nos. 4829, 4830, 4831, August 13, 20, 27, 1948, pp. 152–155; 178, 179; 208, 209; diagrs., figs.

A survey of the indicator diagrams and test data obtained with the Standard Sunbury cathode-ray engine indicator and a calibrating unit that was specially developed for exploring the entire cycle of pressure changes in internal combustion engines operating at speeds from 100 to 4,000 r.p.m.

Ignition Theory Uncovers Electrical Design Facts. C. Cipriani and L. H. Middleton. *SAE Journal*, Vol. 56, No. 10, October, 1948, pp. 47–50, 57, figs. (Extended summary of a paper: A Modern Approach to Ignition.)

Nitrided-Steel Piston Rings for Engines of High Specific Power. John H. Collins, Jr., Edmond E. Bisson, and Ralph F. Schmiedlin. *U.S., N.A.C.A., Report No. 817*, 1945. 20 pp., illus., diagrs., figs. 1 reference. U.S. Govt. Printing Office, Washington. $0.20.

Airport Adjuncts: Schiphol's New Engine Test House. *Airports & Air Transportation*, Vol. 3, (N.S.), No. 63, September, 1948, pp. 51, 52, illus.

Engine Silencer. *Aviation Week*, Vol. 49, No. 13, September, 1948, p. 29, illus. Description of a silencer, produced by Davis Aircraft Silencer Company, which has been installed in light planes.

Antifreeze Properties of Tetrahydrofurfuryl Alcohol and Anhydrous Glycol Solutions. K. A. Glendenning. *Canadian Journal of Research, Section F, Technology*, Vol. 26, No. 5, May, 1948, pp. 209–220, figs. 18 references.

Lightplane Fuel Consumption. Howard Piper. *Air Facts*, Vol. 11, No. 9, September 1, 1948, pp. 42–50, figs.

Piston Engines. *Flight*, Vol. 54, No. 2071, September 2, 1948, p. 278. A table of specifications and performance of 37 engines.

McCulloch Motors Designs Two-Cycle Light Plane Engine. *Aircraft and Airports*, Vol. 10, No. 8, August, 1948, pp. 28, 29, illus.

The Scandia's Engine Installation (Pratt & Whitney Twin Wasp Engines). *Saab Sonics*, No. 3, July–September, 1948, pp. 16–19, 25, illus., diagrs., figs.

ROCKET (4)

Expendable Rockets. Kenneth W. Catland. *British Interplanetary Society, Journal*, Vol. 7, No. 4, July, 1948, pp. 160–169, illus., figs. 2 references.

A description of the Rheinbote, a German rocket missile employing a step propulsive charge, giving specifications, method of sequencing ignition and jettisoning of the steps, and launching techniques. A design is proposed for an expendable crew-carrying rocket using a succession of disposable fuel tanks instead of stepped solid-fuel charges.

The Pioneer Rocket Project of the U. S. Navy. R. C. Truax. *American Rocket Society, Journal*, No. 74, June, 1948, pp. 62–65.

History of Project TED EES 3401 of the Bureau of Aeronautics established at the U.S. Naval Engineering Experiment Station in 1940. The liquid fuel rocket unit that was developed, DU-1, used aniline and nitric acid as fuel and reduced the take-off run of the PBY-2 by 60 per cent. This unit was the forerunner of the liquid JATO unit 38ALDW1500, developed by Aerojet Engineering Corporation, which has been used operationally by the U.S. Coast Guard. The project also developed the nitric-sulfuric acids-monoethyl-aniline rocket power plant of the radio-controlled missile, the Gorgon, which attained a speed of 500 m.p.h.

Rocket Propulsive Efficiency. Donald J. Ritchie. *Rocketscience*, Vol. 2, No. 3, September, 1948, pp. 43–45, figs.

The Synergy Curve. I. Hermann Oberth. (*Wege zum Raumschiffahrt*, Munich, 1929, pp. 168–176.) *Rocketscience*, Vol. 2, No. 3, September, 1948, pp. 38–42, figs.

Low Speed Athodyds. Henry J. Rutowski. *Rocketscience*, Vol. 2, No. 3, September, 1948, p. 54.

Maximum Theoretical Exhaust Velocity. Melvin G. Whybra. *Rocketscience*, Vol. 2, No. 3, September, 1948, pp. 52, 53, 56.

Flight Beyond the Earth. Francis H. Clauser. *SAE Journal*, Vol. 56, No. 8, August, 1948, pp. 25–28, fig. (Extended summary of a paper: Flight Beyond the Earth's Atmosphere.)

Production (36)

Saunders-Roe SR 45. II—Hull Main Frames: Layout and Alignment of Assembly Stocks for Pressure Hull. Wilfred E. Goff. *Aircraft Production*, Vol. 10, No. 119, September, 1948, pp. 295–301, illus., diagrs., figs.

Hawker Sea Fury. I—General Design and Basic Production Methods: Fuselage Sub-Assemblies and Tooling. S. C. Poulsen. *Aircraft Production*, Vol. 10, No. 120, October, 1948, pp. 342–350, illus., cutaway drawings.

Sea Fury in Production; An Outline by the Technical Editor of the Methods Used by Hawker Aircraft Ltd. in the Manufacture of the Royal Navy's Latest Fighter. James Hay Stevens. *Aircraft Engineering*, Vol. 20, No. 235, September, 1948, pp. 252–266, illus., figs.

Technical Development Work in the Saab Workshops. Arne Svensson. *Saab Sonics*, No. 3, July–September, 1948, pp. 20–24, figs.

American Expansion; An Outline of the Newly Authorized Aircraft Production Programme. *Aircraft Production*, Vol. 10, No. 120, October, 1948, pp. 340, 341, illus.

Aircraft Industry: Mid-Year, 1948. *Aviation Week*, Vol. 49, No. 11, September 13, 1948, p. 22, tables.

Production Equipment at Farnborough. *Aircraft Production*, Vol. 10, No. 120, October, 1948, pp. 330–338, illus.

Ground Finishes Eliminate Lapping. H. J. Chamberland. *Aero Digest*, Vol. 57, No. 2, August, 1948, pp. 62, 65, 120, 121, illus.

A summary of the improvements in horizontal-spindle and traverse-table grinding machines that have made micro-inch accuracy possible in high-speed production. Includes discussion of: relative weight of the machine parts for the control of vibration; hydraulic powered traverse, transverse, and vertical motion; forced-feed lubrication, magnetic chucks, cutting fluids, and grinding coolants.

German Measuring Instruments and Machines Used in Precision Engineering. James C. Evans, Cecil O. Taylerson, and others. *Gt. Brit., British Intelligence Objectives Sub-Committee, Final Report No. 1659, Item No. 9.* 144 pp., illus., diagrs., figs. 1 reference. British Information Services, New York. $4.00.

Design and principle of operation of instruments and machines developed in Germany since 1939 for the manufacture and inspection of precision machine parts. Data were collected from 25

targets that included precision instrument manufacturers, firms using the instruments, colleges, and research organizations.

Graphical Representation of the Johansson System of Machining Tolerances. Harold Woodhouse. *Product Engineering*, Vol. 19, No. 10, October, 1948, p. 169, fig.

A Remote Reading Dial Micrometer. M. B. Coyle and F. G. Haynes. *Journal of Scientific Instruments*, Vol. 25, No. 8, August, 1948, pp. 275, 276, diagr., figs.

Rigid Aircraft Inspection Demands Scientific Instruments. W. E. Luff and M. T. Shelhimer. *Automotive Industries*, Vol. 99, No. 5, September 1, 1948, pp. 41, 42, 88, illus.

Design for Forging. *Hawker Siddeley Review*, Vol. 1, No. 3, August, 1948, pp. 16–19, illus.

How to Design Pressure Moldings. James L. Erickson. *Machine Design*, Vol. 20, No. 9, September, 1948, pp. 118–122, 184, 186, illus., diagrs., figs.

Form Dressing; Translation of Template Contours by Pantograph System. (*Aircraft Production*, Vol. 10, No. 117, July, 1948, pp. 235–237.) *The Engineers' Digest*, Vol. 5, No. 7, September, 1948, pp. 347, 348, diagrs.

Shop Equipment and Small Tools; Some Modern Aids to Efficient Production. *Aircraft Production*, Vol. 10, No. 119, September, 1948, pp. 321–323, illus., diagrs., figs.

Flame Spinning; Simultaneous Heating and Roll-Forming of Tubular Work. *Aircraft Production*, Vol. 10, No. 119, September, 1948, p. 315, figs.

Machine Tools at Olympia; A Further Review of Equipment of Interest to the Aircraft and Light Engineering Industries. *Aircraft Production*, Vol. 10, No. 119, September, 1948, pp. 302–315, illus.

Electro-Magnetic Form-Copying; High Fidelity Claimed for New Metrovick Equipment. *Aircraft Production*, Vol. 10, No. 120, October, 1948, pp. 358, 359, illus., diagr.

Alignment Testing. I—Accurate Establishment and Checking of Large Dimensions: Some Instruments in Current Use. K. J. Hume. *Aircraft Production*, Vol. 10, No. 120, October, 1948, pp. 351–353, illus., diagrs.

Propellers (11)

Propeller Considerations for High-Speed Aircraft. Harold H. Warden. *Aeronautical Engineering Review*, Vol. 7, No. 10, October, 1948, pp. 32–35, 87, illus., figs.

Results of tests conducted by the Curtiss-Wright Propeller Division and others have indicated that high-speed propellers can be designed which will give shaft-thrust efficiencies between 80 and 90 per cent at flight speeds up to 600 m.p.h. By varying the thickness ratio and the design lift coefficient blades designed for peak efficiency at 400 m.p.h. will lose only about 7 per cent of their efficiency at flight speeds of 500 m.p.h. with an airplane Mach Number of 0.775 and a tip Mach Number of 1.155. Improvements of approximately 2 to 4 per cent in propeller efficiency can be obtained by incorporating sweepback on blades having thickness and design lift coefficients consistent with present practice in the 400- to 500-m.p.h. range. Since turbine engines appear to be driving propellers operating with a tip speed in the range of 800 to 900 ft. per sec., it is predicted that high-speed propellers, for the immediate future, will have the same general straight plan form and NACA Series-16 airfoil sections, as at present, and square tips. The design lift coefficient will be approximately 0.4 and the section thickness reduced particularly at the tips. Efficiencies comparable to those presently obtained at relatively low speeds are expected to be retained to at least 600 m.p.h.

Evaluation of Reverse-Pitch Propellers as a Means of Reducing the Landing Run of a Flying Boat. C. B. Thawley, L. T. O'Neill, and R. J. Corber. *U. S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 15, August 1, 1948, pp. 11–15, illus., diagr. 1 reference.

Tests with a PBM-5G flying boat with gross weights of 47,000 and 56,000 lbs. showed that the use of reverse-pitch propellers effects a substantial decrease in the landing run of the craft, which decreases with increase in gross weight. Because of the corrosion problems that would result from routine use, the use of this technique should be restricted to emergencies. The nose-up pitch of the airplane does not critically affect the control of the craft on water. The engines do not overspeed or overheat in normal reverse-pitch operation.

Prop Reversing: Aid to Safety? Airlines, CAA Pilots Study Braking Action of Reverse Thrust Propellers; Greater Payload One Issue at Stake. *Aviation Week*, Vol. 49, No. 7, August 6, 1948, pp. 12, 13.

On the Sound Field of a Rotating Propeller. L. Gutin. (*Physikalische Zeitschrift der Sowjetunion*, Vol. 9, No. 1, 1936, pp. 57–71.) *U.S., N.A.C.A., Technical Memorandum No. 1195*, October, 1948. 21 pp., figs.

The sound field of a rotating propeller is treated theoretically on the basis of aerodynamic principles. The calculation of the sound field of the propeller depends on an equation that is valid for small disturbances and for small forward speeds. For the lower harmonics, the directional characteristics and the radiated sound energy are determined and are in agreement with existing (1935) experimental results.

Sound-Level Measurements of a Light Airplane Modified to Recue Noise Reaching the Ground. A. W. Vogeley. *U.S., N.A.C.A., Technical Note No. 1647*, July, 1948. 29 pp., illus., figs. 10 references.

A liaison airplane representative of personal aircraft in the 150- to 200-hp. class was modified by using a five-bladed propeller, gearing the engine, and adding a muffler. The performance equalled or exceeded the unmodified airplane, and the noise level was probably lower than necessary. The acceptability of noise levels remains to be established.

Formulas for Propellers in Yaw and Charts of the Side-Force Derivative. Herbert S. Ribner. *U.S., N.A.C.A., Report No. 819*, 1945. 12 pp., figs. 7 references. U.S. Govt. Printing Office, Washington. $0.15.

Tests of Contra-Rotating Propellers, at Positive and Negative Pitch Settings, on a "Typhoon" Aircraft Model at 5 Deg. Incidence. R. Pankhurst, J. N. Veasey, J. R. Greening, and E. M. Love. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2220*, December, 1945. 16 pp., tables. 4 references. British Information Services, New York. $1.00.

The results of thrust and torque measurements made on propellers in front of an aircraft body at 5° incidence. The propellers were contrarotating two-bladers of $2^7/_8$-ft. diameter and four-bladers of $2^1/_2$-ft. diameter. Tests were also made on corresponding single propellers. A wide range of advance ratio was covered, with blade settings representative of take-off, climb, and braking conditions. Comparisons are made with previous tests with the body at zero incidence.

Tests of Contra-Rotating Propellers of $2^7/_8$-ft. Diameter at Negative Pitch on a "Typhoon" Aircraft Model. R. C. Pankhurst, J. N. Veasey, J. R. Greening, and E. M. Love. *Gt. Brit., Aeronatuical Research Council, Reports and Memoranda No. 2218*, May, 1945. 14 pp., figs., tables. 2 references. British Information Services, New York. $1.00.

Tests of a pair of contrarotating two-bladed propellers to determine their overall thrust and individual torques at pitch settings from 0° to −30° at the 0.7 radius. The advance ratio extended from tunnel "static" to 1.0 for the 0° settings and to 4.0 for the negative pitch settings. The values of the braking thrust coefficients and the usual torque coefficients are plotted and show that the braking thrust varies considerably with blade setting at low advance ratios, but varies little at high advance ratios.

Tests of Model Contra-Rotating Propellers with a "Minimum Body." R. C. Pankhurst, J. N. Veasey, J. R. Greening, E. M. Love. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2270*, August, 1946. 30 pp., illus., figs. 4 references. British Information Services, New York. $1.75.

Tests of Contra-Rotating Propellers of $2^7/_8$-ft. Diameter at Positive Pitch on a "Typhoon" Aircraft Model. R. C. Pankhurst, J. N. Veasey, J. R. Greening, and E. M. Love. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2216*, October, 1945. 38 pp., illus., diagrs., figs. 6 references. British Information Services, New York. $2.20.

Measurements were made of the torque of each of a pair of two-bladed contrarotating propellers and of the overall thrust. Similar measurements were also made over a wide range of advance ratio and blade settings on a single four-bladed propeller of the same total solidity. The results show the differences of blade setting required for equal division of power between the two contrarotating propellers and the comparative propulsive efficiency of single and contrarotating propellers.

Canada Develops Electro-Thermal Propeller De-Icers (National Research Council). *Canadian Aviation*, Vol. 21, No. 10, October, 1948, pp. 33, 50, 54, illus.

Manufacture and Design of (Marine) Propellers in Germany. U.S. Naval Technical Mission in Europe. *Gt. Brit., British*

Intelligence Objectives Sub-Committee, Miscellaneous Report No. 76 (Technical Report No. 545–45), October, 1945. 87 pp., illus., diagrs., figs. British Information Services, New York. $4.00.

Foreign Lightplane Props Analyzed; Design Trends in Post-war Development Abroad Favor Both Automatic and Manually Controlled Pitch Change. Sidney H. Fedan. *Aviation Week*, Vol. 49, No. 15, October 11, 1948, pp. 21, 22, 25, illus., diagrs.

The Hollow Steel Propeller; Hamilton Standard's Hollow Steel Propeller Blade. *Aircraft and Airport*, Vol. 10, No. 9, September, 1948, pp. 16–18, illus., diagr.

Douglas DC-6 Propeller Feathering. *Aero Digest*, Vol. 57, No. 4, October, 1948, p. 37, diagrs.

Another Angle on Propellers. William S. Friedman. *The Pegasus*, October, 1948, pp. 7–10, illus.

A history of the development of the reversible-pitch propeller. Flight tests conducted by the Propeller Division of Curtiss-Wright showed that reversal of propeller-pitch in flight increased the sinking speed and reduced the stalling speed of the airplane.

Steel and Rubber for Aircraft Propellers. Kenneth Rose. *Materials and Methods*, Vol. 28, No. 3, September, 1948, pp. 66–68, illus.

Manufacture of a Hamilton Standard propeller blade, which consists of a steel shell reinforced by an internal hollow steel spar silver-brazed to the shell. The space between the shell and the spar is filled with foamed rubber.

A New Type of Hollow Steel Propeller Blades (Hamilton Standard). Kenneth Rose. *Automotive Industries*, Vol. 99, No. 5, September 1, 1948, pp. 32, 33, 86, 88, illus.

New Propeller Resists Abrasion. *Aviation Week*, Vol. 49, No. 8, August 23, 1948, p. 34, illus.

A new plastic coating developed by the Flottorp Manufacturing Company has been applied to the wood core of conventional fixed-pitch propellers to give them a smooth surface that is impervious to water damage, will not absorb moisture, and is more resistant to abrasion than natural wood.

Reference Literature (47)

DIRECTORIES

Trade Directory; British Manufacturers of Aircraft Materials, Components and Accessories. *The Aeroplane*, Vol. 75, No. 1943, September 3, 1948, pp. 323–336, illus. Names, addresses, and products of over 600 companies classified by 18 general types of products.

The Industry. *Flight*, Vol. 54, No. 2072, September 9, 1948, pp. 317–326.

A directory of the several hundred aircraft, engine, accessory, and materials firms that exhibited at the S.B.A.C. display at Farnborough. The companies are classified according to the type of product or service.

HISTORY

International Air Race (from The United Kingdom) to Christchurch in 1953. *Flying*, No. 11, July 15, 1948, pp. 8–11, 16, illus.

Rotating Wing Aircraft (34)

Flight Investigation of Effects of Rotor-Blade Twist on Helicopter Performance in the High-Speed and Vertical-Authorotative-Descent Conditions. Alfred Gessow. *U.S., N.A.C.A., Technical Note No. 1666*, August, 1948. 27 pp., illus., figs. 8 references.

Comparison of the performance of twisted and untwisted blades showed that an increase of approximately 7 m.p.h., or about 10 per cent, in the limiting forward speed of the helicopter can be obtained by the use of a −8° twist. Once stalling had developed on both rotors, the rotor profile-drag losses incurred by blade stall could be reduced by approximately 40 per cent of the average profile-drag power absorbed by the rotors in the unstalled condition by the −8° twist. In vertical power-off descent, negative blade twist had little effect on the performance of the helicopter. Measured rates of descent in vertical power-off descent were 6 per cent higher than the values calculated from a semiempirical theory. Theoretical and experimental values agreed for the rotor drag-lift ratios of forward-flight autorotative glides.

The Flutter of Helicopter Blades. G. Ficker. *U.S., Air Force, Technical Report No. F-TR-1177-ND (ATI No. 25680)*, July, 1948. 28 pp., figs. 3 references.

An investigation of the effect of advance ratio and blade-root flexibility on the flutter characteristics of helicopter blades has shown that criteria for the critical velocity may be obtained from calculations that disregard the elasticity of the blade and centrifugal force. This simplification of Kuessner's treatment of unsteady aerodynamic forces gives simplified expressions that may be more readily handled. The error introduced by these assumptions is slight and generally tends to increase the safety factor in the criteria.

Helicopter Instability Investigated. *Aviation Week*, Vol. 49, No. 8, August 23, 1948, pp. 26, 27. A summary of the first results of flight tests conducted by the N.A.C.A. to evaluate the flying qualities of the helicopter and determine minimum requirements for future design.

An Outline of Helicopter Design. I. John C. Vogtle. *American Helicopter*, Vol. 12, No. 10, September, 1948, pp. 8, 9, 19, 20, figs.

Preliminary three-view drawing, preliminary weight and balance, applied loads and the moment of inertia of the ship, calculation of the angular acceleration, calculation of the moments of inertia of the ship, and engineering studies—rotor blades.

The Facts and Figures on Commercial Operation. III. Knute Flint. *American Helicopter*, Vol. 11, No. 9, August, 1948, pp. 12, 13, 22.

The availability of helicopter pilots and mechanics, existing training facilities, and the base pay and average income of those employed by A-F Helicopters Inc. Potential fields of operation being considered by the company are spotting of tuna schools, harpooning of sharks, airdrome-shuttle and suburban-transportation service, and geophysical surveying. There is a large potential market for a four-place, two-balded, single-rotor helicopter selling for under $10,000 and a tandem two-engined craft accommodating 15 to 20 persons and selling for less than $50,000. Experience of the author indicates that there eventually will be considerable market for the personal type of helicopter.

Whirling Test Stand Aids Rotor Studies (The Glenn L. Martin Company). *Aviation Week*, Vol. 49, No. 11, September 13, 1948, pp. 28, 30, illus.

Helicopters in the Air Force. A. T. Culbertson. *Aero Digest*, Vol. 57, No. 3, September, 1948, pp. 73, 74, 140, 141, illus.

Rotating-Wing Aircraft. *Flight*, Vol. 54, No. 2073, September 9, 1948, pp. 309, 310, illus. Descriptions of the aircraft of six manufacturers.

The Ninth S.B.A.C. Display. *The Aeroplane*, Vol. 75, No. 1945, September 17, 1948, pp. 374, 375, illus. Includes cutaway drawings of Fairey and Cierva rotorheads.

Ramjet Powered Rotors Used on Flyable Test Stand (Developed by McDonnell Aircraft Co. Under Contract to AMC). *U.S., Air Force, Air Technical Inteligence, Technical Data Digest*, Vol. 13, No. 17, September 1, 1948, p. 10, illus.

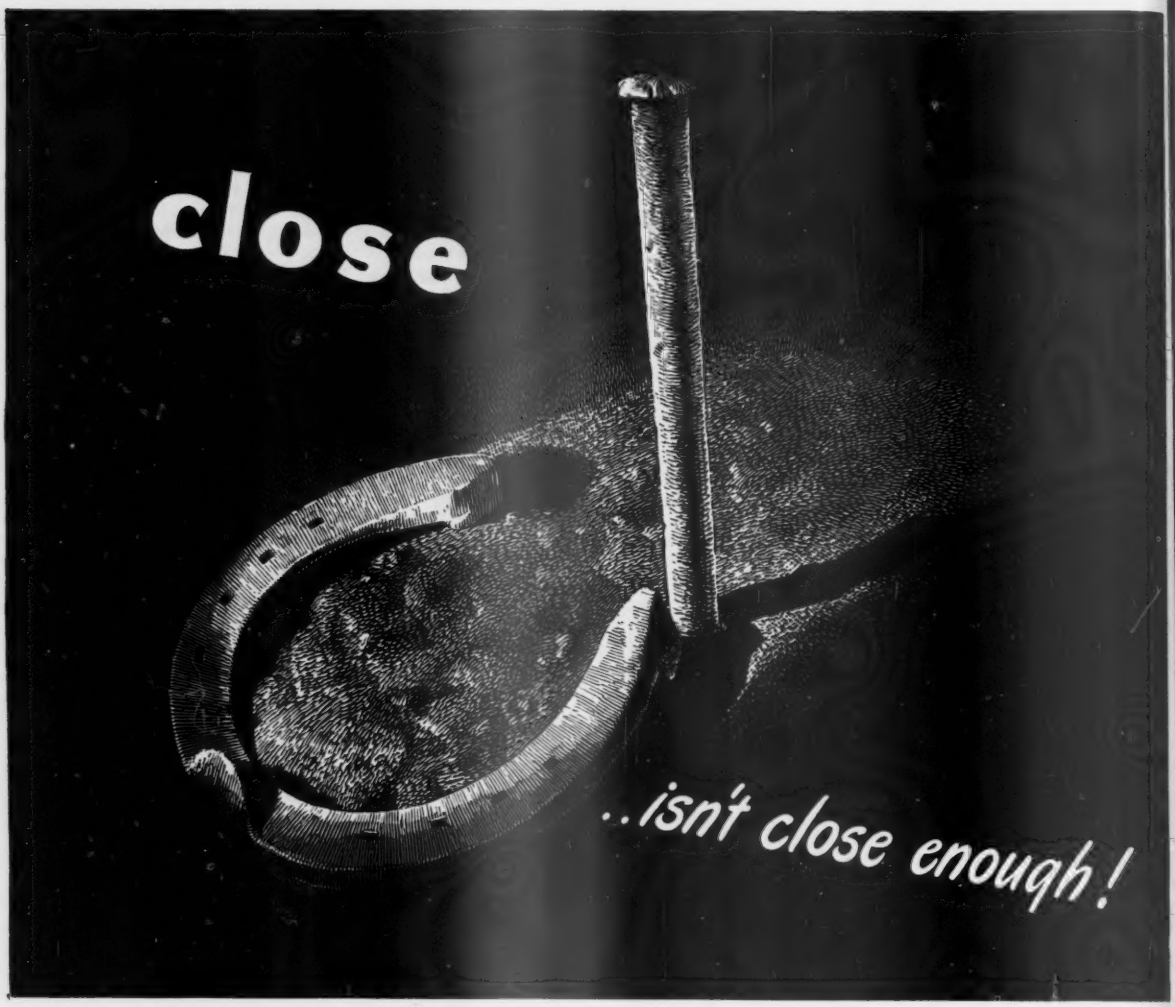
Maintenance of the Bell Helicopter. Alexander Klemin. *Aero Digest*, Vol. 57, No. 2, August, 1948, pp. 67, 68, 114–116, illus., figs.

Helicopter mechanic instruction courses available in the U.S., the curriculum of the Bell Helicopter School, commercial practice in maintenance and overhaul, shop practices, trends in scheduled-maintenance intervals, and maintenance man-hour and replacement costs.

Rotating Wing Arrivals (The Cierva W41 Skeeter Personal Helicopter and the W. 113-Rotor Air Horse). *Aeronautics*, Vol. 19, No. 4, September, 1948, p. 66, diagrs.

Vision and Courage in Helicopter Design. H. A. Marsh. *Shell Aviation News*, No. 121, July, 1948, pp. 9–11, illus.

A survey of helicopter development and a description of the types developed in England. The Cierva Autogiro Company, Ltd. has under construction two development models. The W.11 is powered by a 1,650-hp. Rolls Royce Merlin engine which drives three lifting rotors, two forward and one aft. The pay load of the craft is approximately 3 tons. A modification of the design is being developed with two engines and an increased pay load of 4 to 5 tons. This aircraft will be capable of single-engined operation. The W.14 is a low-cost trainer that has the conventional three-blade lifting rotor and a torque-compensating tail rotor.



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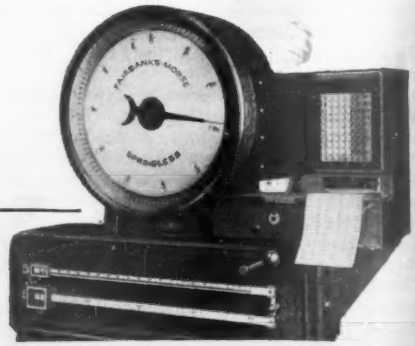

Captive Helicopter for Research Work (Duncan & Bayley XP-2A). *Aero Digest*, Vol. 57, No. 2, August, 1948, p. 70.

An automatically controlled, ground-powered helicopter. It has an 84-in. rotor with automatic azimuth and is powered by a Black & Decker type "P" V-93 universal motor using 110-volts a.c. supplied by the power-source tetherline. In a 15-m.p.h. wind the machine will fly a pay load of $2^1/_2$ lbs. at 960 ft. It has been flown successfully at altitudes from 50 to 200 ft. It will be used in air mass research and for testing antenna characteristics.

Discus Speed Record. *Aeronautics*, Vol. 19, No. 3, August, 1948, pp. 50–53, illus., diagrs.

A discussion of the operating principles of the Fairey Gyrodyne, a helicopter configuration in which the antitorque rotor contributes to the forward propulsion of the aircraft; an eyewitness report of flights in which it established a record for the 3-km. Class G helicopter course; and a detailed description of the aircraft and its Alvis Leonides engine.

Jensen Helicopter's Model 21. G. F. Champlin. *American Helicopter*, Vol. 12, No. 10, September, 1948, pp. 10, 11, illus.

Kaman K-190; An American Helicopter with Servo-Control of Intermeshing See-Saw Rotors. *Flight*, Vol. 54, No. 2070, August 26, 1948, pp. 229, 230, illus., diagrs.

The Kaman Helicopter. Leighton Collins. *Air Facts*, Vol. 11, No. 9, September 1, 1948, p. 24–31, illus., diagr.

U. S. Coast Guard Helicopter Stabilizer. Frank Erickson. *American Helicopter*, Vol. 11, No. 9, August, 1948, pp. 14, 15, illus.

A horizontal airfoil mounted on the nonrotating swash plate of Sikorsky HOS-1 holds the swash plate in a given plane relative to the flight path of the helicopter in forward flight and prevents disturbances of the fuselage from being transmitted to the rotor, thus in turn stabilizing the fuselage. Flights of over 1 hour's duration have been made in moderately rough air without the use of the cyclic pitch control.

Sciences, General (33)

CHEMISTRY

The Rapid Determination of Low Concentrations of Carbon Monoxide in Air. Morris Katz and John Katzman. *Canadian Journal of Research, Section F, Technology*, Vol. 26, No. 8, August, 1948, pp. 318–329, diagrs., figs. 10 references.

GEOGRAPHY

Arctic Magnetic Surveys. Elliott B. Roberts. *Navigation*. Vol. 1, No. 11, September, 1948, pp. 221–227, figs.

MATHEMATICS

Errors in Simultaneous Linear Equations. Raymond Redheffer. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 342, 343. 2 references.

A General Stability Criterion for Linear Oscillating Systems with Constant Time Lag. H. I. Ansoff and J. A. Krumhansl. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 337–341, figs. 6 references.

Two Problems of Mixed Type for the Damped Wave Equation. D. G. Bourgin. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 279–299.

Torsional Rigidity, Principal Frequency, Electrostatic Capacity and Symmetrization. George Pólya. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 267–277, figs.

On Some Singular Solutions of the Tricomi Equation. G. F. Carrier and F. E. Ehlers. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 331–334. 4 references. The solutions have application in the hodograph techniques for the theory of compressible flows.

OPTICS

Optical Finishing of KRS-5 Surfaces. Niel F. Beardsley. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 15, August 1, 1948, pp. 15, 16, illus.

Methods developed for sawing, turning, drilling, grinding, and polishing KRS-5, a eutectic mixture of thallium bromide and thallium iodide. KRS-5 is extremely soft but possesses desirable optical properties. It will transmit infrared radiation of a longer wavelength (out to 50μ) than any other known solid.

PHYSICS

Heat Transfer by Radiation to Surfaces at Low Temperatures. M. Blackman, Alfred Egerton, and E. V. Truter. *Royal Society of London, Proceedings, Series A*, Vol. 194, No. 1037, August 12, 1948, pp. 147–168, diagrs., figs. 17 references. A study of the transfer of heat between the walls of vacuum vessels for the conveyance of liquefied gases.

The Intermediate State of Superconductors. I—Magnetization of Superconducting Cylinders in Transverse Magnetic Fields. M. Desirant and D. Shoenberg. **II—The Resistance of Cylindrical Superconductors in Transverse Magnetic Fields.** E. R. Andrew. **III—Theory of Behaviour of Superconducting Cylinders in Transverse Magnetic Fields.** E. R. Andrew. *Royal Society of London, Proceedings, Series A*, Vol. 194, No. 1036, July 28, 1948, pp. 63–70; 80–98; 98–112, diagrs., figs. 16, 19, 5 references.

Stress Analysis & Structures (7)

The Optimum Proportions of a Long Unstiffened Circular Cylinder in Pure Bending. Herbert Becker. *Journal of the Aeronautical Sciences*, Vol. 15, No. 10, October, 1948, pp. 616–624, figs. 6 references.

The problem of determining the radius and wall thickness of a minimum weight circular cylinder under pure bending is encountered during the design of a missile fuselage. Selection of any of the three common plastic moduli (secant, reduced, and tangent) for use in the buckling stress equation will yield approximately the same optimum design proportions. Furthermore, small deviations from the optimum design geometry will lead to minor weight increases. A simplified design procedure is presented which depends upon the applicability of the secant modulus theory for which substantiating evidence is available. However, since it is not conclusive, the use of the simplified design procedure, which yields a near-optimum design with little effort, must be considered uncertain until such a time as further evidence is available to support the secant modulus theory. In the analysis it is assumed that the buckling stress is linearly proportional to t/R, in agreement with existing data. Discussion of departures from this rule is omitted. The development, which is entirely analytical, employs the three-parameter method of describing stress-strain curves. This leads to expressions for shell radii and weights which are easily compared for each of the three plastic modulus theories.

Primary Instability of Open-Section Stringers Attached to Sheet. Samuel Levy and Wilhelmina D. Kroll. *Journal of the Aeronautical Sciences*, Vol. 15, No. 10, October, 1948, pp. 581–591, figs. 16 references.

A method for estimating the stabilizing effect of the sheet on the buckling load in compression of open-section stringers in sheet-stringer panels failing in primary instability. The torsion bending theory is extended to take into account both the bending stiffness of the sheet and the axial restraint it provides against warping of the stringer as well as effect of the sheet in constraining the center of twist to lie in the plane of the sheet. A comparison of computed and observed maximum loads for panels reinforced by Z-stringers of several designs indicates that for panels reinforced by Z-stringers of a thickness two or more times that of the sheet, the method gives total loads accurate to within about 8 per cent. If the Z-stringers have a bulb or lip at the end of the outstanding flange and have a thickness equal to, or less than, the thickness of the sheet, the proposed method of computing stringer loads may give total loads up to 17 per cent too large. For panels reinforced by Z-stringers having narrow outstanding flanges without a bulb or lip and having a stringer thickness equal to or less than the sheet thickness, the proposed method of computing stringer loads may give total loads up to 35 per cent too large.

Torsion of Thin Walled Multi-Cell Boxes; Formulae for Torque Distribution and Angle of Twist of Types of Boxes Found in Wings, Fins, Tail Planes, etc. G. E. H. Rice. *Aircraft Engineering*, Vol. 20, No. 235, September, 1948, pp. 267, 268, 281, figs.

Determination of Bending Moments in Pressure-Loaded Rings of Arbitrary Shape When Deflections are Considered. F. R. Steinbacher and Hsu Lo. *U.S., N.A.C.A., Technical Note No. 1692*, September, 1948. 127 pp., illus., figs. 4 references.

An analytical method has been derived for determining bending-moment distribution in rings of arbitrary shape under internal pressure loads, with the change of geometric shapes caused by the

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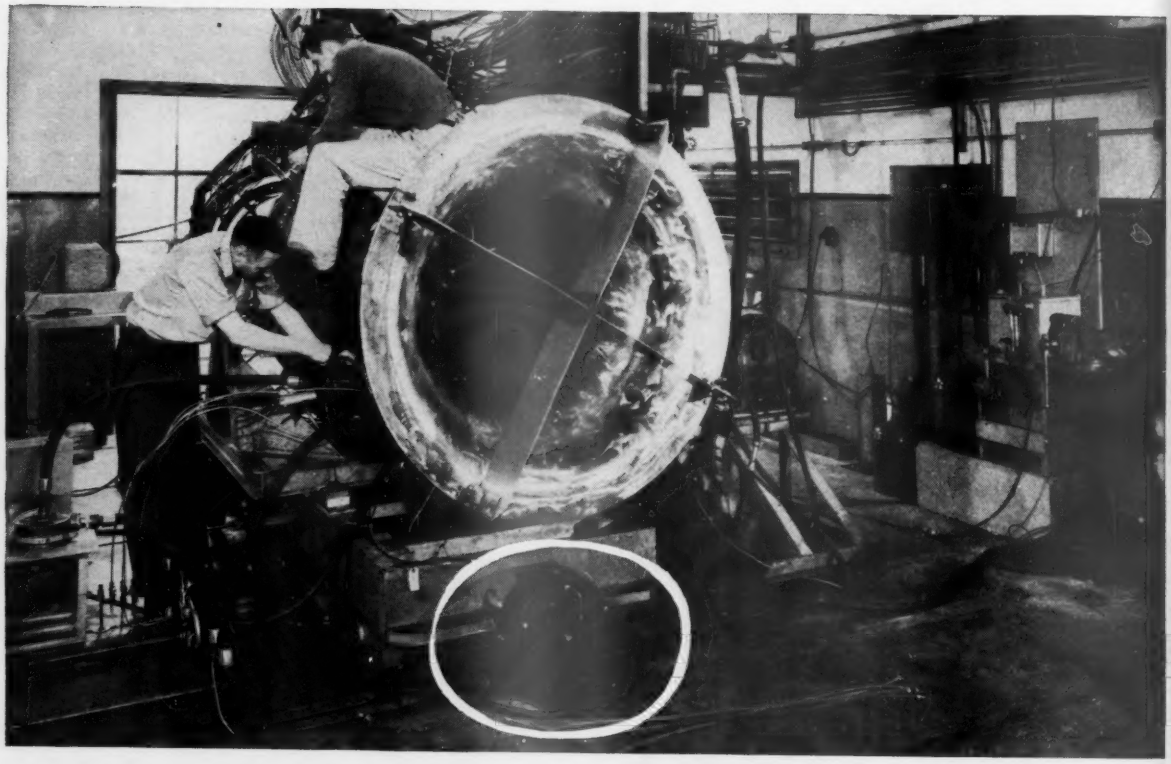

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load being considered. On comparing the present results with the results of solutions in which deflections have been neglected, it is seen that the bending moments previously computed have always been much too conservative. It is believed that by the use of this method curves can be drawn for a typical frame in a fuselage, and from these curves the bending moments and deflections can be estimated for all similar frames.

The Inward Bulge Type Buckling of Monocoque Cylinders. IV—Experimental Investigation of Cylinders Subjected to Pure Bending. N. J. Hoff, Bruno A. Boley, and S. V. Nardo. *U.S., N.A.C.A., Technical Note No. 1499*, September, 1948. 73 pp., illus., figs. 13 references.

Eighteen 24S-T Alclad aluminum-alloy cylinders of 20-in. diameter, with skin thickness varying between 0.012 and 0.025 in. and length varying between 40.5 and 64 in., were tested in pure bending. They were reinforced with either 16 or 28 stringers and either five or six rings. One of the purposes of the investigation was to establish the critical value of the parameter Λ—that is, a value above which failure would occur by general instability and below which panel instability would take place. This value was found to be between 20 and 40 for cylinders with 16 stringers and between 16 and 74 for cylinders with 28 stringers.

The Inward Bulge Type Buckling of Monocoque Cylinders. V—Revised Strain Energy Theory Which Assumes a More General Deflected Shape at Buckling. N. J. Hoff, Bertram Klein, and Bruno A. Boley. *U.S., N.A.C.A., Technical Note No. 1505*, September, 1948. 43 pp., figs. 25 references.

A strain energy theory is developed for the calculation of the critical load for the inward bulge type of general instability of reinforced monocoque cylinders subjected to pure bending. The deflected shape at buckling is assumed to be represented by an expression containing eight free parameters in addition to the two characterizing the wave lengths in the circumferential and axial directions. The theory is applied to two representative cylinders of the GALCIT test series and to two of the PIBAL series. The critical stresses calculated are 8.3 to 22.9 per cent higher than the experimental values.

The Problem of Torsion in Prismatic Members of Circular Segmental Cross Section. A. Weigand. (*Luftfahrtforschung*, Vol. 20, No. 12, February 8, 1944, pp. 333–340.) *U.S., N.A.C.A., Technical Memorandum No. 1182*, September, 1948. 27 pp., figs. 3 references.

The shear stresses and the torsion constant of a circular torque shaft with a flat are found approximately by setting up a function complying with the differential equation of the stress function and determining the coefficients appearing in it in such a way that the boundary condition is fulfilled as nearly as possible. For the semicircle, the approximate solution is in good agreement with the known exact solution. For a series of segmental shapes, experimental values of the torsion constant and of the maximum shear stress show sufficiently close agreement with the calculated values.

The Estimation of Wing Structure Weight. W. Tye and P. E. Montagnon. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2080*, October, 1941. 21 pp., figs. 9 references. British Information Services, New York. $1.30.

Calculation of the Deformation of Two-Spar Wings with Shear-Resistant Skin. F. J. Plantema and A. van der Neut. *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. S.311*, 1947, 12 pp., figs. 8 references. (In English.) (Abbreviated translation of *Rapport Nr. S.297*, March, 1945.)

The equations giving the relation between the internal loads and the deformations of two-spar wings with shear-resistant skins are derived by applying a modification of Castigliano's theorem to an arbitrary part of the wing between an arbitrary pair of consecutive ribs. The deformation of the wing can be described completely by five functions. The five equations necessary to compute the energy are derived, after which the elastic energy, the work of the boundary forces, and the work of the virtual loads should be computed. The solution of the variational problem for minimum energy yields five differential equations that, with the appropriate boundary conditions, determine the five functions. The boundary conditions at the ribs in the plane of symmetry of the wing are then derived.

The Pitching Vibrations of an Aircraft. J. Morris and G. S. Green. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2291*, August, 1945. 23 pp., diagrs., figs. 4 references. British Information Services, New York. $1.45.

A theoretical treatment for calculating the natural frequencies and modes of pitching vibrations of a complete aircraft. The analysis is based on the replacement of the continuous mass system by one consisting of a finite number of discrete masses elastically interconnected. In the course of the investigation, use is made of the deflection coefficient method in the formation of the equations of motion and the escalator process in their marshalling and numerical solution. The analysis has been applied to a single-engined fighter aircraft. The results of resonance test carried out on this aircraft are also given for comparison. Taking all the circumstances into consideration, the calculated and experimental results appear to be in reasonable agreement.

The Choice of Loads for Ultimate and Repeated Design and Test Conditions. P. E. Montagnon and A. Day. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2269*, June, 1945. 5 pp., figs. 2 references. British Information Services, New York. $0.45.

From a detailed analysis of *V-g* records a method is deduced for determining not only the ultimate load appropriate to a given failure rate but also the number of repetitions of a given load that an aircraft structure must withstand on test to ensure that a given rate of accidents due to repetition of this load is not exceeded. In the latter case the importance of the flying life per aircraft is brought out because repetition of a load is not significant unless repeated on the same aircraft.

Strength Considerations Arising from the Use of Elevator "Trimming" Tabs. J. B. B. Owen. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2245*, August, 1939. 19 pp., figs. 9 references. British Information Services, New York. $1.30.

An investigation of the tail loads that may arise from the use of elevator trimming tabs to set an elevator at angles greater than those obtainable by direct manual operation. For an airplane with stick-free stability no special strength problems arise if the rate of operation of the tab is slow. Approximate methods are given for estimating a rate for operating the tab which will keep the maneuvering tail load small and for obtaining the magnitude and chordwise distribution of the load.

The Rolling Vibration of an Aircraft. J. Morris and D. Morrison. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2290*, August, 1945. 12 pp., diagr., figs. 2 references. British Information Services, New York. $0.90.

This report deals with the rolling vibration of an aircraft in which the flexibility of the fuselage and wings are taken into account. To render the analysis tractable each wing was divided chordwise into three portions, the mass of each being assumed concentrated at its center of gravity. The fuselage likewise was divided into four portions. The treatment adopted was that based on the deflection coefficient method and the escalator process, which enables the solution for the whole system to be built up from solutions for the constituent parts of the system. In particular the effect of variation in the engine mounting stiffness on the natural frequencies of the system is investigated. A fully worked example is given relating to an actual aircraft for which a few experimental results were available. The agreement between the calculated and experimental results appears to be fairly satisfactory.

An Analysis of the Airspeeds and Normal Accelerations of Martin M-130 Airplanes in Commercial Transport Operation. Walter G. Walker. *U.S., N.A.C.A., Technical Note No. 1693*, September, 1948. 14 pp. figs. 7 references.

An analysis of gust data obtained on Martin M-130 commercial transport airplanes operated on transpacific routes during the period from 1936 to 1945. Comparisons made with analyses of data from other airplanes support previous indications that airplane speed in regions of turbulent air is significant in the determination of the operational life of airplanes. During the prewar period, operations in the South Pacific indicate greater route roughness than do operations over transcontinental routes of the United States or operations on Caribbean routes.

Upper and Lower Bounds for the Solution of the First Boundary Value Problem of Elasticity. J. B. Diaz and H. J. Greenberg. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 326–331. 4 references.

Torsionssteifigkeit im Fluzzeugbau Verwendeter Systeme (Torsional Rigidity of Structures Used in Aircraft Construction). Ilhan Nural. *Zurich, Eidgenössische Technische Hochschule, Institut für Flugzeugstatik und Flugzeugbau, Mitteilungen Nr. 1*, 1946. 93 pp., illus., diagrs., figs. 14 references. Verlag A.G. Gebr. Leemann and Co., Zurich. (In German.)

Since in actual practice most aircraft wings and fuselages must be hollow structures, this investigation deals with the torsional rigidity of wing systems that consist of two parallel spars serving as connecting members between two closed hollow sections. In order to obtain an insight into the stressing and deformation of such structures and to develop bases for their rapid approximation during the design stages of an aircraft, the results of an analysis of a simplified wing system are verified by measurements made with models with and without fuselage and under both symmetrical and unsymmetrical torsion. The method is then extended to the analysis of actual wing structures, and these results are verified by test measurements on model and full-scale wings. The analysis shows that the overall torsional rigidity of the system depends on the magnitude and the type of loading, symmetrical or unsymmetrical; the rigidity of the spars in the open portion joining the two closed sections; and the structural stability of the closed sections. The open section formed by the spars is the part most susceptible to deformation but its effect in the system can be reduced by the flexural rigidity of the closed sections, which is high because of the high shear strength of skin materials. The rigidity of these sections, although it depends principally on their thickness, can be increased by reinforcing the skin. In the case of a symmetrical torsion the fuselage can serve to increase the torsional rigidity of the wing system. The test measurements on the whole agreed with calculated variation of the angle of deformation with loading. Throughout, the measured distortion was somewhat greater than that computed. This discrepancy can be attributed to the simplifying assumptions made in the calculations.

Buckling of Trusses and Rigid Frames. George Winter, P. T. Hsu, Benjamin Koo, and M. H. Loh. *Cornell University, Engineering Experiment Station, Bulletin No. 36*, April, 1948. 63 pp., figs. 18 references.

The methods that are used to analyze the buckling of aircraft structural elements take into account the properties of adjoining structural members. These methods are presented in a manner applicable to the customary types of structures found in building frameworks, such as rigid frames and welded trusses, and have been modified, elaborated, and supplemented by a number of additional approaches to permit the determination of effective lengths and maximum moments under combined stress, and to account for sidesway. The elastically restrained column is used as a common point of departure to correlate and interrelate the hitherto somewhat disjointed approaches used in aircraft structural analysis.

Structural Testing Pays Off. S. A. Gordon and G. E. Holback. *SAE Journal*, Vol. 56, No. 8, August, 1948, pp. 32–37, illus., figs. (Extended summary of a paper: What Price Structural Testing?)

A discussion of the importance of structural testing and the policies that determine its nature and extent in development of aircraft design; typical testing procedures; and the time and cost factors to be considered in setting up the test schedule.

An Analysis of Life Expectancy of Airplane Wings in Normal Cruising Flight. Abbott A. Putnam. *U.S., N.A.C.A., Report No. 805*, 1945. 9 pp., figs. 11 references. U.S. Govt. Printing Office, Washington. $0.15.

Fatigue of Gusseted Joints. Howard H. Langdon and Bernard Fried. *U.S., N.A.C.A., Technical Note No. 1514*, September, 1948. 40 pp., illus., diagrs., figs. 7 references.

Contains tests run on gusseted joints to determine the effect of gusset edge finish on fatigue life and to compare riveted 24S-T joints with spot-welded 24S-T joints. Results show that edge finish has no effect on the fatigue of either 24S-T or heat-treated alloy-steel gussets and that riveted 24S-T joints have better fatigue characteristics than spot-welded 24S-T joints.

Research Data on Sheet-Stringer Panels; Studies Conducted at National Bureau of Standards. *Aviation Week*, Vol. 49, No. 14, October 4, 1948, pp. 22–24, illus. 6 references.

Structural Considerations of Sheet Stringer Panels; Tests Conducted by the National Bureau of Standards Go Far Toward Proving and Disproving Many Previous Theoretical Investigations. *Plane Facts*, Vol. 5, No. 8, August, 1948, pp. 14–17, 18, illus. 8 references.

Experimental Investigation of the Effects of Plastic Flow in a Tension Panel with a Circular Hole. George E. Griffith. *U.S., N.A.C.A., Technical Note No. 1705*, September, 1948. 17 pp., figs. 7 references.

Seven uniformly dimensioned 24S-T tension panels with a central circular hole were subjected to various loads in order to study the effects of plastic flow at the point of maximum stress concentration. The results, presented in graphical form, show that, as the amount of plastic flow increases, the stress concentration factor is appreciably increased. Subjecting the panels to 100 repeated loading cycles caused no change to occur in the maximum values of the stress and strain concentration factors.

Minimum-Weight Design of Simply Supported Transversely Stiffened Plates Under Compression. Alexander Gomza and Paul Seide. *U.S., N.A.C.A., Technical Note No. 1710* September, 1948. 23 pp., figs. 2 references.

Plastic Buckling of a Rectangular Plate Under Edge Thrusts. G. H. Handelman and W. Prager. *U.S., N.A.C.A., Technical Note No. 1530*, August, 1948. 97 pp., figs. 8 references.

The stress-strain relations that exist during the plastic buckling of a rectangular plate under edge thrusts are developed as a special case of the theory of plastic flow of Handelman, Lin, and Prager. The fundamental euqation of plastic buckling of a simply compressed plate and typical boundary conditions for a narrow strip and a simply supported plate are used to compare this theory with the Engesser-von Kármán theory of the plastic buckling of beams and to develop an analytical formula for the critical stresses. These stresses are higher than those obtained with the theories of Timoshenko and Ilyushin. The torsional buckling of a cruciform section under compression is studied by treating each flange as a simply compressed plate. The use of the theory of plastic flow eliminates the discontinuities that are present at the neutral surface when the state of stress and strain in a body is described by a theory of plastic deformation such as that used by Ilyushin.

The Elements of the Buckling of Curved Plates. H. L. Cox and E. Pribam. *Royal Aeronautical Society, Journal*, Vol. 52, No. 453, September, 1948, pp. 551–565, figs. 44 references.

The difficulty introduced into the analysis of the buckled form of a complete tube by the lack of conformity with the edge conditions of a curved plate is evaded by ignoring the detail of the buckled form. By concentrating on the wave length and amplitude of the buckle, the behavior of the curved plate at and after buckling is represented qualitatively. This representation is then rendered quantitative by referring it to the limiting case of tubes and flat plates. For these cases exact solutions are available. This simplified analysis permits the influence of initial irregularities from the true cylindrical form to be taken into account. The final results include the effect of this factor and provide a satisfactory guide to practical construction for cases of unstable buckling. Comparison of theoretical curves with test results indicates that the parameters in the theoretical formula represent reasonably well the behavior of curved plates in the early postbuckling range. The buckling stress of plates with outward bulges on their initial shapes are uniformly higher than those plates with equivalent inward bulges, but none of the plates tested exceeded substantially the theoretical buckling value.

Critical Shear Stress on an Infinitely Long Plate in the Plastic Region. Elbridge Z. Stowell. *U.S., N.A.C.A., Technical Note No. 1681*, August, 1948. 19 pp., figs. 3 references.

The theory of plastic buckling has been used to determine, from the stress-strain curve of the material, the plasticity reduction factor in the formula for the buckling stress of a long plate under uniform shear. Limited data on the shear buckling of 24S-O aluminum-alloy plates in the plastic region tend to confirm the value of the reduction factor predicted. The theory indicates that the restraint against rotation along the edges of a plate has little or no effect on the value of the factor.

Principles of Moment Distribution Applied to Stability of Structures Composed of Bars or Plates. Eugene E. Lundquist, Elbridge Z. Stowell, and Evan H. Schuette. *U.S., N.A.C.A., Report No. 809*, 1945. 14 pp., figs. 12 references. U.S. Govt. Printing Office, Washington. $0.15.

Experimental Investigation of the Post-Buckling Behavior of Stiffened, Flat, Rectangular Plates Under Combined Shear and Compression. II. W. K. G. Floor. **Text and Tables. Figures.** *Netherlands, Nationaal Luchtvaartlaboratorium, Amsterdam, Rapport Nr. S. 328*, December 30, 1947. 83, 62 pp., photos, diagrs., figs. 5 references. (In English.)

An investigation of the diagonal tension field in stiffened flat plates loaded by a combination of shear and of compression parallel to the shorter edges of the individual panels. The thicknesses of the two panels tested were 0.42 and 1.27 mm. and their length-to-width ratio was 3.16. The longitudinal edges were approximately simply supported. The compression of the longi-

tudinal stiffeners, the compression of the lateral stiffeners, and the shearing strains were measured, and the shape of the buckled plate was determined by profile and slope recordings. From these the stress distribution in the plate and the wave-form ratios were computed. These calculations indicate the degree of development of the tension field as compared with the completely developed (Wagner) tension field. Koiter's theory is evaluated in a manner that yields numerical results both for the stress distribution and for the wave-form ratios. Direct comparison between theory and experiment can then be made.

Critical Axial-Compressive Stress of a Curved Rectangular Panel with a Central Chordwise Stiffener. S. B. Batdorf and Murry Schildcrout. *U.S., N.A.C.A., Technical Note No. 1661*, July, 1948. 23 pp., figs. 6 references.

Theoretical analysis shows that a curved rectangular panel can be made to resist additional axial compression without buckling by the use of a central chordwise stiffener. The strengthening effect decreases as the curvature increases and as the ratio of the circumferential dimension to the axial dimension decreases. From the semiempirical results contained in this report the axial-compressive buckling strength of a curved rectangular panel with a central chordwise stiffener can be estimated.

Direct-Reading Design Charts for 75S-T Aluminum-Alloy Flat Compression Panels Having Longitudinal Straight-Web Y-Section Stiffeners. Norris F. Dow and William A. Hickman. *U.S., N.A.C.A., Technical Note No. 1640*, August, 1948. 38 pp., figs. 7 references.

The charts permit the direct determination of all the panel proportions required to achieve minimum weight in 755-T Alclad compression panels with longitudinal straight web Y-section stiffeners as well as all the proportions, other than those for minimum weight, which will also meet the given design conditions. The charts can be used to study the effect of changing the design conditions or to select proportions other than those for minimum weight which may be more suitable for a particular application.

The Effective Stress Concentration at the End of a Crack Having Regard to the Atomic Constitution of Materials. C. Gurney. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2285*, December, 1945. 5 pp., figs. 3 references. British Information Services, New York. $0.45.

A Simplified Polariscope for Industrial Use. Ray W. Clough. *Product Engineering*, Vol. 19, No. 9, September, 1948, pp. 124–128, illus., diagrs., figs. The design and construction details of the light source, polarizer frames, lens frame, camera mount, and loading frame of a simple inexpensive polariscope that is sufficiently accurate for industrial photoelastic stress analysis.

Thermodynamics (18)

Generalized Thermodynamics of High Temperature Combustion. C. N. Satterfield, H. C. Hottel, and G. C. Williams. *Massachusetts Institute of Technology, Division of Industrial Cooperation, Report No. 17* (*D.I.C. 6351*), May 15, 1947. 49 pp., figs., tables. 40 references.

A set of tabulations of generalized thermodynamic data which encompass all composition of probable interest in the four-component system, carbon-hydrogen-oxygen-nitrogen. The data for the various ratios of the elements in chemical equilibrium are given at temperatures up to 3,200° K. at two pressures, 14.7 and 300 lbs. per sq.in. per atmosphere. The ratios include those that are encountered in mixtures of fuels such as hydrogen, gasoline, alcohols, ammonia, air, hydrogen peroxide, and nitric acid. These tables make possible the rapid determination of the adiabatic flame temperature and the available work or heat from any power or heating cycle operating within these limits. Included in the appendixes are a tabulation of the values of the internal energy, the enthalpy, and the entropy for eleven chemical species and the equilibrium gas compositions in mol fraction units for each combination of elements studied.

The Influence of Incombustible Vapours on the Limits of Inflammability of Gases and Vapours in Air. J. H. Burgoyne and G. Williams-Leir. *Royal Society of London, Proceedings, Series A*, Vol. 193, No. 1035, July 21, 1948, pp. 525–539, diagrs., figs. 13 references.

A flow method less tedious than static methods was developed to determine the limits of flame propagation in complex gases. From data obtained by both methods, diagrams have been plotted for a number of combustibles with inert vapor and air which show completely the compositions of flammable and nonflammable mixtures, from which the limiting safe composition of the mixtures can be determined. In a mixture of methyl bromide and air, the combustibles tested were placed in the following order of increasing susceptibility to extinction: hydrogen, ethylene, coal gas, benzene, cyclohexane, *n*-hexane, carbon monoxide, and methane. Complete limits were also delineated for mixtures with air of hydrogen and freon 12; *n*-hexane, and freon 12; and of methane and carbon tetrachloride. In some cases additions of methyl bromide appreciably lowered the lower limit of flame propagation. In all cases a sufficient addition of the extinguisher always caused the upper and lower limits to converge. The effect of methyl bromide upon the limits of the sample of debenzolized coal gas which was tested was also calculated from the data for hydrogen, ethylene, carbon monoxide, and methane by using Coward's extension of Le Chatelier's rule and agreement within 10 per cent was obtained. Measurements made with tubes of $1^{7}/_{8}$- and 4-in. diameter were compared. The larger tube showed little effect on the lower limits but caused considerable deviations in the upper limits.

Effect of Reynolds Number in the Turbulent-Flow Range on Flame Speeds of Bunsen-Burner Flames. Lowell M. Bollinger and David T. Williams. *U.S., N.A.C.A., Technical Note No. 1707*, September, 1948. 29 pp., diagr., figs. 9 references.

A correlation of the flame speed in a Bunsen burner in the turbulent flow range at sea-level atmospheric conditions has been empirically derived in terms of the normal flame speed (transformation velocity), burner diameter, and Reynolds Number. The normal flame speed of an explosive mixture was shown to be an important factor in determining its turbulent flame speed. Turbulent flame speed is a function of both the Reynolds Number of the turbulent flow in the burner tube and of the tube diameter.

Zonal Combustion in Tubes. S. A. Schaaf. *Quarterly of Applied Mathematics*, Vol. 6, No. 3, October, 1948, pp. 257–266, figs.

Combustion is assumed to extend over a definite zone or region that moves with time through the gas. Conditions that are under effectively one-dimensional, the effective pressure, velocity, etc., of the gas at any time in a given cross section of a half-open tube are assumed to be characterized by single quantities. The rate with which energy is released during combustion, the velocity with which the burning region progresses into the fresh gas, and the duration of burning of a given layer of gas depend on the degree of turbulence in the tube and the strength of a combustible mixture. Explicit results are obtained which are good to first order terms in a perturbation expansion in a parameter proportional to the average rate of energy release. The results are for the pressure at the closed end of the tube, the position of the flame front, and the velocity of gas flow at the open end of the tube and are graphed for turbulent and static initial conditions.

Gas Dynamic Treatment of Exothermic and Endothermic Discontinuities. D. G. Samaras. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 26, No. 1, pp. 1–21, figs. 9 references.

Endothermic and exothermic processes in gas dynamic flows taking place in a narrow zone may be considered as discontinuities. The variation of the static and total head density ratio, pressure ratio, and temperature ratio as well as the angle of deviation, area ratio, and exit normal Mach Number have been found as functions of the entry normal Mach Number and of heat addition. In addition to these, some other useful quantities such as the area ratio parameter, the difference of the square of velocities and the normal velocity produce have been evaluated. It was found that, in a discontinuity, heat can be added until the exit normal Mach Number reaches unity (choking). Depending on the entry normal Mach Number, only a limited amount of heat can be added at the discontinuity. An exothermic discontinuity behaves as an expansion when the entry normal Mach Number is subsonic, and it is accompanied by a drop in static pressure, density, and total head pressure. An exothermic discontinuity behaves as a compression shock wave when the entry normal Mach Number is supersonic, and it is accompanied by an increase in static pressure and density and a decrease in total head pressure. An endothermic discontinuity always behaves as a compression shock wave, and it is accompanied by an increase in static density, pressure, and total head pressure. The results and conclusions may be useful in a better understanding of many nearly discontinuous phenomena such as flame fronts, condensation and evaporation fronts, and other similar problems.

Spectroscopic Studies of Low-Pressure Flames; Temperature Measurements in Acetylene Flames. A. G. Gaydon and H. G. Wolfhard. *Royal Society of London, Proceedings, Series A*, Vol. 194, No. 1037, August 12, 1948, pp. 169–184, figs. 12 references.

Thermodynamics of Equilibrium and Stability. J. S. Wang. *Chinese Journal of Physics*, Vol. 7, No. 3, June, 1948, pp. 132–175, figs.

Generalized Thermodynamics of High-Temperature Combustion. H. C. Hottel, G. C. Williams, and C. N. Satterfield. *American Society of Mechanical Engineers, Transactions*, Vol. 70, No. 6, August, 1948, pp. 667–676, figs. 17 references.

Aspects of a Theory of Unimolecular Reaction Rates. N. B. Slater. *Royal Society of London, Proceedings, Series A*, Vol. 194, No. 1036, July 29, 1948, pp. 112–131, figs. 15 references.

Combustion. Bernard Lewis and Guenther von Elbe. *Industrial & Engineering Chemistry*, Vol. 40, No. 9, August 28, 1948, pp. 1590–1596. 144 references. A review of developments in fundamental research and technical developments since 1938.

An Investigation of Aircraft Heaters. XXVIII—Equations for Steady-State Temperature Distribution Caused by Thermal Sources in Flat Plates Applied to Calculation of Thermocouple Errors, Heat-Meter Corrections, and Heat Transfer by Pin-Fin Plates. L. M. K. Boelter, F. E. Romie, A. G. Guibert, and M. A. Miller. *U.S., N.A.C.A., Technical Note No. 1452*, August, 1948. 42 pp., figs. 9 references.

The equation is derived for the steady-state temperature distribution caused by a thermal source or sink in a flat plate surrounded on either side by fluids of different temperatures. The formula is used to obtain an analytical prediction of the thermal error that occurs when thermocouples are used to measure the temperature of a flat plate; a determination of the effect of thermal conductivity and thickness of the metal plate on the heat-transfer rate in pin-fin plates; and a correction factor for the heat meter which includes the effect of the flow of heat around the heat meter.

Thermal Conductivity of Metals at High Temperatures. I—Description of the Apparatus and Measurements on Iron. L. D. Armstrong and T. M. Dauphinee. *Canadian Journal of Research, Section A, Physical Sciences*, Vol. 25, No. 6, November, 1947, pp. 357–374, diagrs., figs. 3 references.

An apparatus for measuring the thermal conductivity of metals in the temperature range 0° to 800°C. is described. The method utilizes unidirectional heat flow in a cylindrical sample in a vacuum. The advantages of the method are outlined and comprehensive analysis of possible errors in the measurements is included. Measurements in Armco iron indicate that results with an absolute error of less than 2 per cent may be obtained. The results of measurements on a sample of Armco iron gave thermal conductivities of 0.181_9 cm.Gm.sec. units at 0°C. and 0.069_8 cm.Gm.sec. units at 800°C. A change in slope of the thermal conductivity-temperature curve was found at a temperature of approximately 375°C. and is tentatively attributed to the presence of 0.03 per cent nickel impurity.

Water-Borne Aircraft (21)

A New Approach to Determining the Hydrodynamic Characteristics of Flying Boats During Flight Tests. F. W. S. Locke, Jr. (*International Congress of Applied Mechanics, 7th, London, September 6, 1948, Preprint.*) *U.S., Bureau of Aeronautics (Navy Dept.), Design Research Division, Report No. 1063*, August, 1948. 45 pp., illus., figs. 22 references.

Simplified full-scale testing techniques for obtaining quantitative data on the low-speed maneuverability, the prehump directional stability, longitudinal stability during take-off and landing in smooth water, the main spray characteristics in smooth water, and the rough-water landing behavior of flying boats. The only specialized instrumentation required is an air-speed indicator calibrated for low speeds, a visual trim-angle indicator, elevator-position indicator, a gang accelerometer, and a heel-angle indicator. A still camera on shore or on a crash boat is used to obtain the main spray characteristics and spray data at the propeller plane is obtained with only the engine r.p.m. indicator. The techniques relate, whenever possible, the numerical values to sensations experienced by the pilot. Their primary purpose is to determine the usable characteristics of the aircraft and not to establish correlation with model tests. Although quantitative evaluation of a new craft may be obtained quickly and easily, the data may be of little assistance in understanding the determined behavior.

Dynamic Loads in Aeroplanes Under Given Impulsive Loads with Particular Reference to Landing and Gust Loads on a Large Flying Boat. D. Williams and R. P. N. Jones. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2221*, September, 1945. 31 pp., figs. 2 references. British Information Services, New York. $1.75.

Impulsive loads such as landing and gust loads tend to be the deciding factor in the structural design of the wings of large air planes (or flying boats). This report shows how to calculate the dynamic effects of such loads, so that calculations may be easily carried out by the average aeronautical engineer. The method is applied to a large flying-boat wing for both landing and gust loads to discover whether the large flying boat is at a disadvantage from a wing structure weight point of view, compared with the large landplane in having the landing load concentrated at the hull. The flying-boat wing, like the landplane wing, is likely to be designed on gust rather than on landing loads.

Effect of Afterbody Length and Keel Angle on Minimum Depth of Step for Landing Stability and on Take-Off Stability of a Flying Boat. Roland E. Olson and Norman S. Land. *U.S., N.A.C.A., Technical Note No. 1571*, September, 1948. 27 pp., illus., diagrs., figs. 4 references.

Model tests were made to investigate the effects of depth of step, angle of afterbody keep, and length of afterbody on the take-off and landing stability of a model of a flying boat. The results show the minimum depth of step required to attain landing stability as a function of afterbody length and keel angle. An empirical formula is fitted to the results. The formula agrees fairly well with the results from tests of other models.

Analysis of Planing Data for Use in Predicting Hydrodynamic Impact Loads. Margaret F. Steiner. *U.S., N.A.C.A., Technical Note No. 1694*, August, 1948. 36 pp., figs. 7 references.

General hydrodynamic-impact-load equations are applied to the planing, float and corrections are made to the coefficients that are used in defining the effect of the apparent additional mass in order to give agreement with planing data. The effect of gravity at low Froude Numbers and the effect of chine immersion upon the apparent additional mass are included in the resultant equations, which may be substituted directly in the general hydrodynamic-impact-load equations.

Theoretical and Experimental Wing-Tip Accelerations of a Small Flying Boat During Landing Impacts. Daniel Savitsky. *U.S., N.A.C.A., Technical Note No. 1690*, September, 1948. 34 pp., illus., figs. 4 references.

A simplified analytical method for predicting the time history of the accelerations along the wing of an airplane during landing impact is compared with wing-tip-acceleration data from full-scale landing tests of a small seaplane. Impact force-time variation is approximated by a sine curve that agrees fairly closely with experimental data for the period considered. Structural properties had little effect on hydrodynamic impact force and were such that only the fundamental bending mode had an important effect on wing-tip accelerations. Damping was usually sufficient to stop wing vibrations excited by impacts prior to the most severe impact of a landing.

Economical Aspects of Flying Boat Operation. C. H. Schildhauer. *S.A.E. National Aeronautic Meeting, Los Angeles, October 6–9, 1948, reprint.* 5 pp., illus., figs.

Research and development have placed the large flying boat alongside the land airplane in overall logistic efficiency. The flying boat should be an integral factor in the national air-transport industry to assure the existence of a comprehensive potential for military conversion.

Effect of Length-Beam Ratio on Aerodynamic Characteristics of Flying-Boat Hulls Without Wing Interference. John G. Lowry and John M. Riebe. *U.S., N.A.C.A., Technical Note No. 1686*, September, 1948. 13 pp., figs. 4 references.

An increase in the length-beam ratio decreased the minimum drag coefficient and slightly increased the longitudinal stability in a manner similar to that indicated for hulls with wing interference. The hull-alone drag coefficients were consistently higher than the hull drag coefficients with wing interference.

Analysis and Modification of Theory for Impact of Seaplanes on Water. Wilbur L. Mayo. *U.S., N.A.C.A., Report No. 810*, 1945. 12 pp., figs. 16 references. U.S. Govt. Printing Office, Washington. $0.15.

Wind Tunnels (17)

Wind-Tunnel Testing Problem in Superaerodynamics. Hsue-Shen Tsien. *Journal of the Aeronautical Sciences*, Vol. 15, No. 10, October, 1948, pp. 573–580, figs. 9 references.

The flow behavior of rarefied gas displays intensified boundary-layer and viscosity effects that necessitate that nozzles and test sections of wind tunnels be designed according to the exact Navier-Stokes equations instead of the approximate boundary-layer equations. The extremely low pressure encountered in superaerodynamic flow requires the use of manometers with a sensitivity of about 10^{-2} microns. Density can best be determined by measuring the characteristic absorption of certain wave lengths of light by low-pressure gases. The thickness of the shock in supersonic flow and the thickness of the boundary layer render the pitot tube impractical for the measurement of flow velocity. A calculation of the sensitivity of the hot-wire anemometer shows it to be applicable. The radiation heat loss of a test model and heat input due to radiation from the walls of the test section impose similarity rules for model testing in superaerodynamic flows which appear difficult to fulfill.

A Note on the Toxic Effects of Some Chemicals Previously Recommended for Use in Wind-Tunnel Technique and on Vapour and Gas Explosion Risks in Wind Tunnels. E. R. A. Merewether, J. H. F. Smith, R. C. Pankhurst, and F. H. Burstall. *Gt. Brit., Aeronautical Research Council, Reports and Memoranda No. 2198*, December, 1946. 3 pp. 3 references. British Information Services, New York. $0.25.

Information on the toxic effects of some chemicals that have been recommended for use for transition indication in wind-tunnel technique. The use of hydrogen sulphide and of sprays of lead compounds, nitrobenzene, nitroluene, chloronaphthalenes, and glycols should all be avoided. Instead of hydrogen sulphide acting on lead compounds, the ammonia technique should be developed; in the china-clay technique the use of ethyl salicylate or methyl salicylate (oil of wintergreen) is suggested. As far as is known, neither ammonia nor these salicylates are likely to prove harmful to the operators. To avoid building up concentrations of vapor by repeated application, some form of ventilation is required when spraying. For example, the working section of the tunnel should be suitably screened off temporarily and ventilation provided by means of a small fan installed in a duct discharging to the open air.

World's Largest; Supersonic Wind Tunnel Unveiled by NACA Has 6 × 8 ft. Test Section (Lewis Memorial Laboratory, Cleveland). Robert Hotz. *Aviation Week*, Vol. 49, No. 15, October 11, 1948, pp. 14, 15, illus.

Testing at Toulouse. Denis Wright. *The Aeroplane*, Vol. 75, No. 1944, September 10, 1948, pp. 356–358, illus., diagr. The wind tunnel of the French S.N.C.A.N.

Special Wind Tunnels for Testing Aluminum Oil Coolers (Standard-Thomson Corp.). *Automotive Industries*, Vol. 99, No. 5, September 1, 1948, p. 27, illus.

Looking Ahead in Test-Bed Design. *De Havilland Gazette*, No. 46, August, 1948, pp. 14–16, illus., cutaway drawing. The design of the test tunnels of de Havilland Propellers Ltd. at Hatfield.

Interferometer Designed to Study Air Flow and Heat Transfer. *U.S., Air Force, Air Technical Intelligence, Technical Data Digest*, Vol. 13, No. 17, September 1, 1948, p. 7.

Wind-Tunnel Procedure for Determination of Critical Stability and Control Characteristics of Airplanes. Harry J. Goett, Roy P. Jackson, and Steven E. Belsley. *U.S., N.A.C.A., Report No. 781*, 1944. 16 pp., figs. U.S. Govt. Printing Office, Washington. $0.15.

Wall Interference in a Two-Dimensional-Flow Wind Tunnel, with Consideration of the Effect of Compressibility. H. Julian and Walter G. Vincenti. *U.S., N.A.C.A., Report No. 782*, 1944. 30 pp., figs. 18 references. U.S. Govt. Printing Office, Washington. $0.20.

The Effect of Screens in Wind-Tunnel Wide-Angle Diffusers. *U.S., National Bureau of Standards, Technical Report No. 1277*, August, 1948. 7 pp., illus., fig.

Wind-tunnel investigations have shown that damping screens placed across the section upstream of the entrance cone of wide-angle diffusers are an effective means of reducing turbulence in the test section. Screens are most efficient when located in the vicinity of the natural separation point of the flow.

Effect of Screens in Wind-Tunnel Wide-Angle Diffusers. *U.S., National Bureau of Standards, Technical News Bulletin*, Vol. 32, No. 10, October, 1948, pp. 120–122, figs.

Supersonic Tunnel for Missiles. R. B. Pearce. *Aviation Week*, Vol. 49, No. 8, August 23, 1948, pp. 22–24, diagrs., figs. 5 references.

Design and operation of the variable-area-nozzle supersonic wind tunnel built by the North American Aviation, Inc. A $1^3/_4$- by $4^1/_2$-in. test section was selected to permit the miniature tunnel to be operated from the 95 lbs. per sq.in. per gage compressed air available at the aircraft plant. Mach Numbers of 1.85, 2.45, and 2.80 have been obtained. The variable nozzle area permits rapid change of Mach Number. Instrumentation includes a schlieren optical system. The boundary layer in the subsonic section is controlled by the injection of an air jet. Test results are compared with those obtained in the German supersonic wind tunnel at Peenemünde.

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Aeronautical Reviews

Books

High Speed Aerodynamics

By Harold W. Sibert. New York, Prentice-Hall, Inc., 1948. 289 pp., diagrs. $6.00.

This is a textbook written especially for engineers. The author states that courses in thermodynamics and incompressible fluids are desirable but not necessary prerequisites. Differential and integral calculus and a knowledge of elementary aerodynamics are the minimum needs. Thus, it appears that the book is intended for college juniors or seniors. It is difficult to present to this audience a subject as formidable in mathematical complexity as the aerodynamics of compressible fluids. The present author has undertaken to do so by selecting topics that can be treated without advanced methods of analysis and without use of advanced concepts of physics.

Beginning with fundamental dynamical and thermodynamical relations, he proceeds to simple aerodynamic considerations such as dynamic and impact pressures, critical conditions, determination of position error, and aerodynamic heating. The next chapters bring the student to theoretical aerodynamics: viz., reversible-adiabatic flow in a stream tube; one-dimensional channel flow; and, finally, the differential equations of steady inviscid flow. The linear-perturbation theory (subsonic and supersonic) is given, as are Prandtl-Meyer flow, Busemann's "parabolic formula," and supersonic flow past a cone (nonlinear). Two chapters are devoted to shock waves, in which the Rankine-Hugoniot relations are set up. The volume closes with a descriptive chapter on airplane characteristics at high (subsonic) Mach Numbers, an explanation of the simple sweepback effect, and a discussion of experimental techniques. All this is accomplished in the space of only 269 pages, plus a number of charts and tables!

The author's decision to omit the hodograph theories in a book of this character is understandable, and the same is probably true of the theory of characteristics. It is more difficult to understand the absence of any mention of nonsteady phenomena, since they seem to be essential to the understanding of compressible flows and do not require advanced mathematics. The book seems to be crammed with formulas but lacking, in spots, in discussions of physical principles. For undergraduate readers, the reviewer would prefer to have descriptive chapters devoted to boundary layers and the effects of viscosity and heat conduction and to careful explanations of the *isentropic*, *irrotational*, and *reversible* approximations. It would seem more important to point out the physical effects of nonlinearity and their profound significance near sonic speed than to work out the calculation of nonlinear supersonic cone flow, as is done here.

There are a few glaring shortcomings. One is the derivation of the familiar Prandtl-Glauert rule, which is attempted without considering boundary conditions and becomes absurd. Another is the presentation of Busemann's parabolic formula as an approximation to the pressure behind a shock wave, which "is found to give fairly accurate results" elsewhere. In the chapter on shock waves, the remarkable statement is made that "since the flow of gas through a shock wave is essentially frictionless, the flow is reversible." In another place, the reader is told that "the aeronautical engineer is concerned with entropy only when he is studying flow through a shock wave." The problems given at the end of each chapter seem to require only straightforward substitution in the formulas of the chapter.

In the reviewer's opinion, the volume suffers, essentially, from a hurried style, which has precluded careful and precise discussion of physical facts. It must be admitted that the book is an admirable handbook of present-day methods in high-speed aerodynamics, but it seems destined to produce "handbook aerodynamicists."

W. R. SEARS
Director, Graduate School of Aeronautical Engineering, Cornell University

Introduction to Applied Mathematics

By Francis D. Murnaghan. New York, John Wiley & Sons, Inc., 1948. 389 pp., diagrs. $5.00.

Problems with many degrees of freedom such as those encountered in airplane stability, flutter analysis, vibration, ballistics, and elastic deformation are so complex that their understanding and solution requires mathematical aids that are normally not taught in undergraduate schools. These aids can be acquired either in graduate work or by self-study. It is interesting to note that these modern mathematical tools are nearly a century old but their practical application to physics and engineering is fairly new and dates possibly to the year 1925 or so. Engineers only recently realized how much easier some of their problems could be solved if one mastered such subjects as matrix and tensor calculus. Aeronautical scientists adopted matrix calculus about 12 years ago, applying it to flutter and stability calculation. Significantly, one of the first practical books on matrix calculus was published by three aeronautical engineers: Frazer, Duncan, and Collar, *Elementary Matrices and Some Application to Dynamics—Differential Equations*, Cambridge University Press, 1938.

The aeronautical engineer or applied physicist will welcome Dr. Murnaghan's book, which goes beyond simple matrix calculations. The author deals systematically with powerful emphasis, on fundamentals, with such subjects as harmonic analysis, spherical harmonics, and Bessel functions. There is an especially thorough and clear analysis of boundary value problems and integral equations. A full treatment of mechanical problems by means of the calculus of variation and a detailed explanation of operational calculus are also included. From the many electrical examples cited one could construe that advanced applied mathematics can be used only in this branch of engineering. Thus, the book's value and universal appeal would be enhanced if the examples were taken not only from electrical engineering but also from aerodynamics, hydrodynamics, elasticity, and optics.

On the whole, however, it is an excellent text on a deep and difficult subject, recommended for self-instruction because of its precise language. The constant emphasis on the fundamental aspect of the subject and the rigorous attention to easily mastered notations will make this book a welcome addition to the none-too-plentiful literature on practical applied mathematics.

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Statements and opinions expressed in Book Reviews are to be understood as individual expressions and not necessarily those of the Institute.

The Analytical Development of Curves and Streamline Shapes

By Harry H. Haase. Amityville, N.Y., Deemar Company, 1948. 151 pp., diagrs. $4.00.

Mr. Haase is Development Engineer with Republic Aviation Corporation, and the book has grown out of several years' practice in design and lofting. That is the way the best books come into being, and Mr. Haase's book is no exception to this rule. As Alexander Kartveli points out in a fine introduction, the requirements of modern transonic or supersonic airplane design are high. It is impossible to generate sufficiently faired surfaces by eye or feel. The designer must use analytical methods, accurate in theory, simple and flexible in application. The author has produced such a method. He expresses the ordinates of a curve as a polynomial function with fractional exponents of the abscissa of the form

$$y = K_1 n_1 + K_2 n_2 + K_3 n_3 \ldots$$

With suitable modification of constants or exponents, he generates wings or curves of any desired shape; can modify a circle or an ellipse flexibly; convert the equation of an ellipse into power form; make a curve pass smoothly through a point and satisfy slope conditions; and check the smoothness of a curve by studying changes in curvature, among many other things. Also, once a power series has been established, problems in mensuration, area, surface, and volume become simple. It is an added merit that the book is short and that only the simple elements of the theory of equations and differential equations are involved. There is further merit in the fact that the book provides large photo-offset pages, extremely clear curves, and tables and calculations that are immediately intelligible. The best way to show in detail what problems Mr. Haase tackles is to list chapters and some of the subheadings:

Chapter I, Circle and the Ellipse. Adaptation of the Ellipse to the Development of Contour Line. Plotting an Ellipse by means of Trigonometric Functions. *Chapter II, The Power Curves.* Development of Multi-Term Power Curve Equations. Correction of Equations for Change in Thickness Ratio. *Chapter III, Curvature and Points of Inflection.* Determining the Smoothness of a Curve. *Chapter IV, Further Application of the Power Curves. Chapter V, Mensuration of the Lines, and Volumes Formed by Power Curve Equations.*

This book should serve many drafting offices, and the Republic Aviation Corporation should be congratulated on its public spirit in permitting the method to be broadcast.

DR. ALEXANDER KLEMIN
Consulting Engineer

Documentation

By S. C. Bradford. London, Crosby Lockwood & Son, Ltd., 1948. 156 pp. 10s. 6d.

This contribution to bibliographical literature has at least one valuable feature—namely, that of pointing out the importance of documentary sources to research, the inadequacies and wastefulness of present abstracting and classifying methods, and the urgent need for steps toward a solution of these problems. However, it is doubtful whether librarians and persons charged with bibliographic control in the United States will be favorable to Dr. Bradford's adherence to the typically continental complications of the Universal Decimal Classification and to its use in the classified arrangement of abstracts in publications, even though consideration of this classification system may be of some significance in the solution of current problems.

With the present state of bibliographic control, especially in connection with the increasing volume of scientific and technological literature, under close examination for the purpose of effecting vitally needed improvements and with so many librarians and researchers today investigating the potential uses of punch cards and other machine methods, a book such as this is most welcome, even though it be only another step toward a solution rather than the solution itself. Dr. Bradford shows a fine awareness of current needs in scientific and technological research and a strong desire to meet the challenge presented by today's

enormous mass of literature that is handled by methods completely unsatisfactory for the needs of research personnel. Excellent suggestions are those of coordinating the activities of British and American abstracting bodies and of establishing cooperation between abstracting periodicals.

The book consists of a preliminary presentation of background material in several chapters, including observations on documentation and methods of indexing, all intended to show the need for a plan to remedy the defects existing because of lack of coordination among abstracting periodicals and because of the lack of uniform methods of classifying abstracts of technological documents. Many readers will no doubt be in complete agreement with these first chapters.

There follows an explanation of the plan offered as a solution. It consists, in short, of the abstracting by periodicals of only those articles that are in their particular groups of journals, the passing on of the other articles to the abstracting journals most closely concerned, and of the classifying of abstracts in all these journals according to a universally accepted classification system. The two parts of the plan are probably acceptable either in this or in modified form to most persons concerned with these problems. The proposal as to arrangement of abstracts will probably be less generally acceptable. The question of classification systems is probably one whose solution must await developments in machine methods during the next few years. The mistake has too often been made of trying to adapt old systems to a new development when an entirely new foundation is required. Readers will probably agree that a new classification method should be designed concurrently with the machines that seem to be the solution, at least for a few decades, to the problems of controlling bibliographic information.

KEITH G. BROWN
Project Librarian
Standard Aeronautical Indexing System

Book Notes

AERODYNAMICS

NACA-University Conference on Aerodynamics, June 21–23, 1948. (U.S., National Advisory Committee for Aeronautics.) Pasadena, California Institute of Technology, Durand Reprinting Committee, 1948. 411 pp., illus., diagrs. $3.00.

With this volume the Durand Reprinting Committee initiates a program undertaken with the cooperation of the National Advisory Committee for Aeronautics to reissue out-of-print unclassified N.A.C.A. publications. The Durand Committee requests suggestions for the titles of reports believed to be of sufficiently wide interest to warrant reprinting. The conference papers in the present volume were prepared to review the status of a number of fields of interest and to summarize the more important wartime advances that are no longer classified. In order to orient reference material for further study, the volume contains over 550 bibliographical references at the ends of papers. Contents: Stability of the Laminar Boundary Layer, by Neal Tetervin; A Review of Approximate Methods in Subsonic Compressible Flow, by Carl Kaplan; Wind-Tunnel-Wall Corrections, by S. Katzoff; A Review of Propeller Theory, by Blake W. Corson, Jr.; Characteristics of Wing Sections at Subcritical Speeds, by Albert E. von Doenhoff and Laurence K. Loftin, Jr.; Characteristics of Wing Sections at Transonic Speeds, by John V. Becker; Prediction of Wing Characteristics, by Thomas A. Toll and Franklin W. Diederich; Maximum-Lift and Stalling Characteristics of Wings, by James C. Sivells; Factors Affecting Static Longitudinal Stability and Control, by Charles J. Donlan; Factors Affecting Lateral Stability, by John P. Campbell; Dynamic Stability, by Leonard Sternfield; Flying and Handling Qualities of Airplanes, by William H. Phillips; Helicopter Research Problems, by Alfred Gessow; A Survey of Flutter, by I. E. Garrick; Air Inlets, By Norman F. Smith; Two-Dimensional Supersonic Wing Theory, by Walter G. Vincenti; The Use of Conical and Cylindrical Fields in Supersonic Wing Theory, by Robert T. Jones; The Use of Source and Sink Concepts in the Calculation of Wing Characteristics at Supersonic Speeds, by Clinton E. Brown; Unsteady Lift in High-Speed Flight, by Harvard Lomac; A Survey of Methods for the Calculation of Flow around Bodies of Revolution at Supersonic Speeds, by Antonio Ferri; and Some Considerations of Aerodynamic Heating, by Coleman DuP. Donaldson.

Underwater Explosions. Robert H. Cole. Princeton, N. J., Princeton University Press, 1948. 437 pp., illus., diagrs. $7.50.

Following a brief introductory chapter on the primary phenomena in an underwater explosion, equations are developed for describing the motion of a fluid which are the basis for hydrodynamical relations in underwater explosions. The detonation process as a physical event and shock-wave theory are next analyzed, including the Kirkwood-Bethe detailed evaluation of shock-wave propagation, Penney's theory based on the Riemann equations, and the propagation theory of Kirkwood and Brinkley. The next three chapters take up pressure-measuring gages, photography of underwater explosions, and shock-wave measurements. The final three chapters deal with Motion of a Gas Sphere, Secondary Pressure Waves, and Surface and other effects. A bibliography of about 150 references is included. This book is based largely on research carried out in the years 1941–1946 and is the first comprehensive survey of knowledge of the subject. The author was for 5 years with the Underwater Explosives Research Laboratory at Woods Hole and is now at Brown University.

Yacht Racing; The Aerodynamics of Sails and Racing Tactics. Manfred Curry. Revised and Enlarged 5th Edition. New York, Charles Scribner's Sons, 1948. 298 pp., illus., diagrs. $7.50.

The influence of Dr. Curry's writings on yacht design has made itself felt in the wide acceptance in such things as the Marconi rig, Genoa jib, parachute spinnaker, and the plank boom. The author takes his observations from all sources, including birds' wings, winged seeds, airplane wings, and from his own experiments, ranging from simple experiments with pieces of paper to wind-tunnel tests. In his preface he makes the statement that research in racing tactics has been more or less completed, no new ideas having appeared in several years. The first half of this book shows that this is not true of yacht design. The ideas expressed are supported by experimental data and by the usual excellent photographs and diagrams. This is the first revision of this book since 1935.

AIRPLANE DESIGN & DESCRIPTION

Design Requirements for Aeroplanes for the Royal Air Force and Royal Navy. (Gt. Brit., Ministry of Supply, Air Publication 970). London, H. M. Stationery Office; New York, British Information Services, 1948. Various Paging, diagrs. $4.00.

The chapters included in this edition are Structural Strength and Design for Flight, Structural Strength and Design for Land and Water, Detail Design and Strength of Materials, Installations, and Maintenance. Appendixes include Definitions, Wing Load Distribution, Load Distribution—Tail Unit, Standard Atmospheric Conditions, and Standard Physical Characteristics of the Average Airman. There is a detailed subject index.

AIRPORTS & AIRWAYS

Navigation and National Security, prepared by The Ad Hoc Committee on Navigation. Washington, The National Military Establishment, Research and Development Board, 1948. 70 pp.

This report contains the recommendations of the Committee for an overall program on air, marine, and land navigation, with particular emphasis on the problem of air navigation and air-traffic control. A single basic national system of air navigation and traffic control is recommended to be developed and installed which will satisfy the requirements of all users to the greatest extent feasible. An authoritative fulltime planning and steering group, an executive director, and a system engineering group should be established in a single organization charged with the responsibility for research, development, and standardization of the common air navigation system, responsible preferably to one Government agency. The appendixes, consisting of 50 pages, contain the Functional Requirements for Land, Marine, and Air Navigation; Summary of Organizations Active in the Field of Aids to Navigation; and a Selected Bibliography on Air Navigation and Traffic Control, containing 108 titles.

ATOMIC ENERGY

The Control of Atomic Energy, a Study of Its Social, Economic and Political Implications. James R. Newman and Byron S. Miller. New York, Whittlesey House, McGraw-Hill Book Company, Inc., 1948. 434 pp. $5.00.

The authors have been familiar with the Governmental executive and legislative background of the Atomic Energy Act through their official capacities with the Office of War Mobilization and Reconversion and the Senate Special Committee on Atomic Energy. They helped with the drafting of the bill and observed its progress through enactment. This book aims to analyze the meaning of the Act, interpret its contents, and evaluate some of its implications. Though the authors are both lawyers, they point out that the scope of the legislation has required them to go beyond the bare legal interpretation of its provisions into many fields of knowledge. The texts of various acts and regulations, a glossary, and a bibliography are included in the useful appendixes.

ELECTRONICS

Industrial Electronics Reference Book, by Electronics Engineers of the Westinghouse Electric Corporation. New York, John Wiley & Sons, Inc., 1948. 680 pp., illus., diagrs. $7.50.

Nearly 50 electronics engineers have cooperated in the writing of this book. It is designed for the practicing engineer who requires knowledge of the principles of electronics and the limitations and possibilities of electronic apparatus in its applications to industrial processes. Fundamental and theoretical concepts are reviewed in Chapters 1 through 3 (including basic laws governing the production and control of electrons, kinetic theory of gases, and atomic structure) and separate chapters on Electron Emission and the Control of Free

Electrons. Chapters 4 through 10 cover the design and operation of vacuum tubes, gas tubes, X-ray tubes, cathode-ray tubes, photoelectric devices, and ultraviolet radiators. Chapter 11 through 14 cover the different resistance forms, capacitance and inductance, tuned circuits, filters, and transformers. The different circuits for rectifiers, amplifiers, and oscillators and various control circuits are covered in Chapters 15 through 18. Transmission line and antenna design and application factors are covered in Chapters 19 and 20. About half of the book Chapters 21 through 34, is devoted to the various types of industrial equipment, such as power rectifiers and inverters, radiofrequency heating equipment, power-line carriers, electronic instruments, industrial x-ray equipment, electrostatic precipitation, motor control, regulation devices, resistance-welding control, photoelectric control, ultraviolet radiations, and radar. The final two chapters deal with maintenance of tubes and electronic apparatus. Bibliographies are included at the ends of most chapters.

Vacuum Tube Amplifiers, edited by George E. Valley, Jr., and Henry Wallman. (Massachusetts Institute of Technology, Radiation Laboratory Series No. 18.) New York, McGraw-Hill Book Company, Inc., 1948. 743 pp., diagrs. $10.

This book deals with the principles of design for circuits that are essentially linear, discussing amplifiers designed to have extreme values in one of the several pertinent characteristics, such as bandwidth, sensitivity, linearity, or constancy of gain over a long period of time. The theoretical basis for the high-fidelity reproduction of transient signals is laid in the first chapter, including a summary of the steps needed to determine the transient response of a given network. The next two chapters apply the theory to direct or "video" pulse amplifiers, and pulse amplifiers of large dynamic range. Synchronous and Staggered Single-Tuned High-Frequency Bandpass Amplifiers, Double-Tuned Circuits, High-Frequency Feedback Amplifiers, pulse response of Bandpass Amplifiers, Amplifier Measurement and Testing are next discussed. The following three chapters deal with stabilized gain of low-frequency amplifiers, low-frequency feedback amplifiers, and direct-coupled amplifiers. The final third of the book deals at length with noise in chapters entitled Amplifier Sensitivity, Minimal-Noise Input Circuits, and Measurement of Noise Figure. An existence theorem on the physical realizability of filter amplitude characteristics is included in an appendix.

Electron-Optics. Paul Katschek. Translated by Arthur Palme. 2nd Edition. Boston, Mass., American Photographic Publishing Company, 1948. 183 pp., illus., diagrs. $3.50.

This translation of a book published in Stüttgart in 1937, was issued first in 1944 and contained an additional chapter by the translator on later developments. This edition includes a second supplementary chapter by Dr. Walter Hausz of the General Electric Company. Dr. Hatschek's original purpose was to present the fundamentals of electron optics without mathematics for the reader not previously acquainted with the subject.

U.S.A. Omni Range Improvements. (ICAO Circular No. 5-AB/4). Montreal, International Civil Aviation Organization, June, 1948. 23 pp., diagrs. $0.10.

This is a summary of the technical improvements during the past 1½ years on the VHF Omnidirectional range system and the present status of the program, as reported by the Technical Development Service of the U.S. Civil Aeronautics Administration.

Bibliography of Reports on Tropospheric Propagation. (U.S., Central Radio Propagation Laboratory, Report No. CRPL-2-3). Washington, National Bureau of Standards, July 23, 1948. 126 pp. Approximately 1,200 reports are listed under 19 subjects, with an author index.

FLIGHT SAFETY & RESCUE

Crash Fire and Rescue Equipment at Aerodromes. (ICAO Circular No. 4-AN/3). Montreal, International Civil Aviation Organization, June, 1948. 18 pp. $0.10.

This a summary of the requirements for crash fire and rescue equipment pending the development of international standards that can be recommended for adoption. A table of the quantities and rates of discharge of foam and CO_2 for fires involving aircraft of various size is included, as well as a bibliography of 16 items.

FUELS & LUBRICANTS

Alkylation of Alkanes. Vol. 1. Patents on Alkylation of Alkanes. Gustav Egloff and George Hulla. (American Chemical Society Monograph No. 107). New York, Reinhold Publishing Corporation, 1948. 1138 pp., diagrs. $20.

This is the first of three projected volumes on the alkylation of alkanes, the reaction by which alkylates, a fundamental component of 100-octane aviation gasoline, are procured. This volume covers over 800 patents, arranged according to processes: Catalytic Alkylation, subdivided by catalysts, covering over half the book; Thermal Alkylation; Combination Processes of Alkylation with other hydrocarbon reactions; Miscellaneous Processes, subdivided by reactants; and Demethylation of Alkanes. The authors point out that the principles of alkylation of alkanes have broad implications that can be applied to amines, alcohols, aeromatic hydrocarbons, and many other organic compounds. Volumes II and III will cover the scientific and technical literature and reports.

Conversion of Petroleum. A. N. Sachanen. 2nd Edition. New York, Reinhold Publishing Corporation, 1948. 602 pp., diagrs. $11.

This new edition of a book first published in 1940 includes material on such new developments as catalytic cracking and alkylation; the Fischer-Tropsch process; thermal cracking, including the polyforming process; and catalytic isomerization, hydroforming, and dehydrogenation. New chapters are introduced on the conversion of petroleum gases into motor fuel and on catalytic cracking. Synthetic products other than gasoline are discussed in the final chapter. Extensive bibliographies are included at the ends of chapters.

Survey of Commercial Aviation Gasoline Characteristics, July 1947 Production. W. C. Holliman, M. G. Barker, and Nancy Potts. (U.S. Bureau of Mines, Report of Investigations No. 4353). Washington, Bureau of Mines, July 1948. 23 pp., diagrs.

LABORATORIES, AERONAUTICAL

Report on the Question of United Nations Research Laboratories and Observatories. (UNESCO/Nat. Sci. 24/1947.) Paris, United Nations Educational, Scientific, and Cultural Organization, 1947. 96 pp.

Among the international scientific laboratories proposed are included installations for the study of astronomy and meteorology in the Southern Hemisphere, high-altitude problems, oceanography of Asiatic Seas, and the Antarctic and Arctic and the equatorial zones of the earth.

LAWS & REGULATIONS

Engineering Contracts and Specifications. Robert W. Abbett. 2nd Edition. New York, John Wiley & Sons, 1948. 327 pp. $3.75.

This new edition of a book first published in 1945 contains over 50 per cent additional material, with a new chapter on construction insurance, rewritten and expanded sections on prequalification and arbitration, and three chapters on specification writing instead of one. While the original material on Government methods has been retained and brought up to date, this edition includes an expanded treatment of contract procedure for private work. The author is a consulting engineer of the Knappen Tippetts Abbett Engineering Company. The book is intended for both classroom and reference use.

A Study of Engineering Registration Laws. A. M. Sargent. Detroit 3, Mich., 19669 John R Street, The Author, 1948. 60 pp. $0.75.

The author's purpose is to present a clear picture of the licensing situation, and he has done a good job. He concludes that the original intent of professional engineering registration laws is sound and valid. Enforcement should be confined to the protection of the public when the public is not free to exercise its own self-interest and judgment, and the definitions of such instances should be precisely and clearly stated in the law. Such definition is not commonly found in the licensing laws of today, which also lack uniformity. The character of the licensing laws should be permissive rather than mandatory until a body of practice and precedent has been established to make them voluntarily binding. The author recommends registration by all engineers qualified for it but believes that the work of the various engineering societies and organizations is of greater value than laws in building the profession.

MANAGEMENT & FINANCE

Production Cost Trends in Selected Industrial Areas. Philip Neff, Lisette C. Baum, and Grace E. Heilman. Berkeley, Calif., University of California Press, 1948. 249 pp., diagrs. $4.00.

The areas selected for this study were Los Angeles, San Francisco, Chicago, Detroit, Cleveland, and Pittsburgh. Date on cost ratios are presented for all manufacturing; for durable goods manufacturing, including transportation equipment; for nondurable goods manufacturing; and for selected industries, including aircraft and parts. The data are summarized in the final chapter on conclusions. Cyclical fluctuation in the six areas, manufacturing statistics for 1929–1939, and interindustry relationships in the United States in 1939 are discussed in appendixes.

Business, Legal, and Ethical Phases of Engineering. D. T. Canfield and J. H. Bowman. New York, McGraw-Hill Book Company, Inc., 1948. 358 pp., diagrs. $4.50.

The purpose of this textbook is to present the essentials of business administration and the legal and ethical phases of engineering for a single course for upperclass engineering students. The authors aim to emphasize money, management, and men, assuming that machines and materials are well known to the engineer, who is required also to be familiar with the commonly used financial, business, and legal language. The four parts of the book deal with Business Economy, Cost Determination, Business Law, and Engineering Procedures, including bids and specifications, patents, insurance, and professional ethics. The authors are professors of electrical engineering at Purdue University.

MATERIALS

Solid and Laminated Wood Bending. W. C. Stevens and N. Turner. London, H.M. Stationery Office, 1948. 71 pp., illus., diagrs. 5s.

The purpose of this book is to present a general handbook of practice in the processes of wood bending, including such theoretical background as is necessary to explain the adoption of the various procedures. The first part deals with Solid Bending, including the selection and preparation of material, softening treatments, hand and machine bending, and the setting of bends. Part 2 deals with the process of laminated bending, pressing laminae to shape, glue setting, movement and distortion of laminated bends, and theoretical considerations. The authors are with the Forest Products Research Laboratory of the Department of Scientific and Industrial Research.

Steel and Its Heat Treatment. D. K. Bullens and the Metallurgical Staff of the Battelle Memorial Institute. 5th Edition. New York, John Wiley & Sons, Inc., 1948. 2 Vols., 489. 293 pp.; illus., diagrs. $6.00, $4.00.

The last revision of this standard work appeared in 1938. Volume 1 of this edition deals with definitions, terminology, and fundamental concepts, the limitations and uses of tests applied to evaluate the suitability of steel for heat treatment and for engraving use, and with the principles underlying the various types of heat treatment for carbon or alloy steel. Volume 2 deals with applications of the principles; tools; processes; quenching media; relation of heat-treatment to welding; and the heat-treatment of steel castings, malleable iron, and cast iron. A third volume will deal with engineering carbon, simple alloy, complex alloy, and special purpose steels. Bibliographies are included at the ends of chapters.

METEOROLOGY

Causes of Catastrophe; Earthquakes, Volcanoes, Tidal Waves, and Hurricanes. L. Don Leet. New York, Whittlesey House, McGraw-Hill Book Company, Inc., 1948. 232 pp., illus. $3.00.

The purpose of the author is to review the existing knowledge of the various forms of natural catastrophe for those without special training in these phases of geophysics. The greater part of the book is devoted to earthquakes and volcanoes. Chapters are included on tidal waves and hurricanes and typhoons. The book is well illustrated with drawings, maps, and photographs. The author is in charge of the seismograph station at Harvard University.

OPERATIONS, COMMERCIAL

Airline Operations. R. Dixon Speas. Washington, American Aviation Publications, 1948. 363 pp., illus., diagrs. $5.00

The first edition of this book was reproduced from typewritten copy. It was favorably reviewed by Charles Froesch in the AERONAUTICAL ENGINEERING REVIEW for April, 1948. In this first printed edition, the material has been largely reorganized and rewritten and increased by more

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By H. H. Katz. Complete, thoroughly professional preparation for work in the aircraft drafting room — teaches all fundamental drafting techniques, the special practices of aircraft drafting, pictorial drawing, lofting. Over 1000 large, clear detail drawings make it easy to learn. Much valuable production and engineering information also included — shop processes, weight calculations, bill of materials, etc. 45 tables of data. Excellent for self instruction, reference or training new workers.

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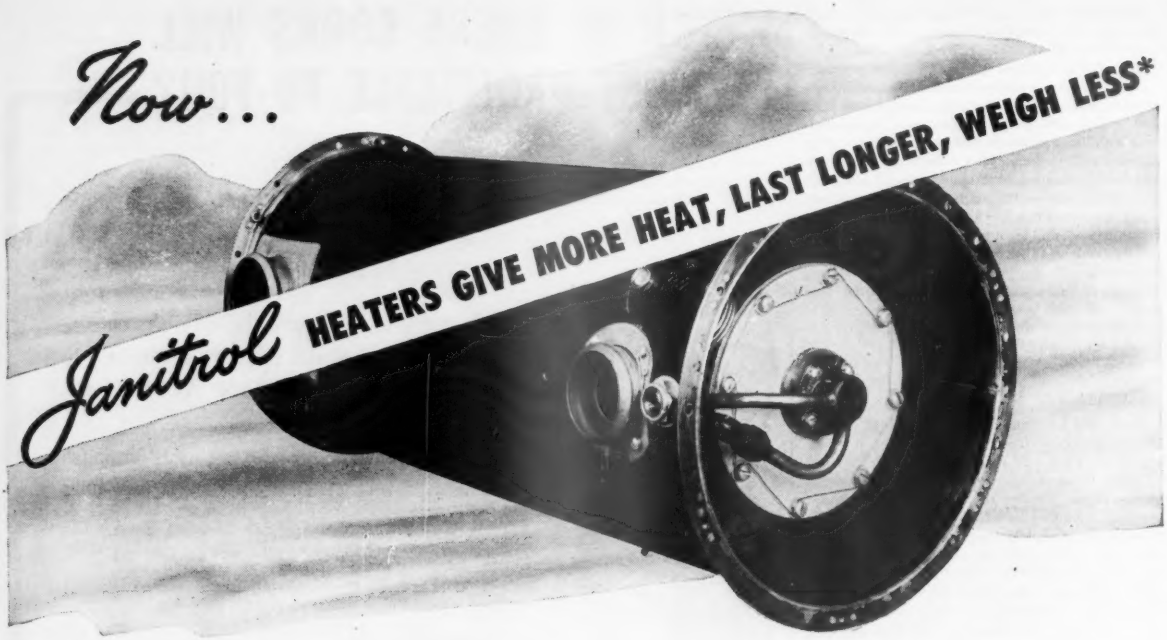

*THANKS TO Inconel

Janitrol aircraft heaters had won wide recognition for efficiency and dependability.

But Janitrol engineers wanted to make these heaters still lighter, deliver still more heat, last even longer.

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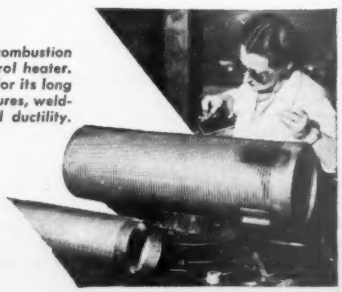
Janitrol Whirling Flame Heaters are supplied in sizes from 15,000 B.T.U. to more than 600,000 B.T.U. per hour. For further information, write to *Janitrol Aircraft Heater Division, Surface Combustion Corporation, Toledo 1, Ohio.*

Welding an Inconel combustion chamber for a Janitrol heater. Inconel was chosen for its long life at high temperatures, weldability, strength, and ductility.



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than 50 per cent. The illustrative material is almost doubled, and new chapters have been added on Aircraft Maintenance and Engineering and Communications and Meteorology. An introductory Historical Summary has been added. It can be recommended as the most authoritative and up-to-date book on air-line engineering available.

Statistical Summary, Air Transport, No. 1. (Document 5390-AT/658.) Montreal, International Civil Aviation Organization, April, 1948. 125 pp. $0.50.

Operating statistics are given for 51 divisions of 38 international air lines of 18 countries, as reported to ICAO. About half the statistics, including all U.S. air lines, are complete to the end of 1947, and most of the remainder to June, 1947, or a later month. Metric units are used for all data pertaining to weight and distance.

Facilitation Division: Final Report of the Second Session. (Document 5464-FAL/535.) Montreal, International Civil Aviation Organization, June, 1948. 68 pp. $0.25.

Recommendations are presented of the Facilitation Division on forms for travel papers dealing with the entry and departure of aircraft, passengers, cargo, and crew; formalities at stops, including forced landings; customs and public health procedures; and provisions for currency exchange, air-line company material and personnel, personal flying and nonscheduled air transport, detention and care of crew, passengers, and cargo, facilities and services, multiple taxation, search, rescue and salvage, and violation of national laws. A bibliography of 39 documents is included.

POWER PLANTS

The Internal Combustion Engine. C. Fayette Taylor and Edward S. Taylor. Revised Edition. Scranton, Pa., International Textbook Company, 1948. 339 pp., illus., diagrs. $4.25.

This new edition of a textbook published in 1938 has been revised particularly in the chapters on Friction, Air Capacity of Four-Stroke Engines, Two-Stroke Engines, and Performance. A chapter has been added on Gas Turbines and Jet Engines. Pertinent new experimental data have been incorporated into the text and figures, and the bibliography of more than 475 titles contains some new references. The authors are professors at the Massachusetts Institute of Technology.

REFERENCE LITERATURE

FILMS

Educators Guide to Free Films, compiled and edited by Mary Foley Horkheimer and John W. Diffor. 8th Edition. Randolph, Wisconsin, Educators Progress Service, 1948. 345 pp. $5.00.

This edition of this useful and well-indexed guide lists 75 free aeronautical films, and about 100 aeronautical slide films. A number of additional films and slide films are listed under such related subjects as Shop Work, Physics, Transportation, History (World War II), and Geography.

HISTORY

Q.E.D., M.I.T. in World War II. John Burchard. New York, John Wiley & Sons, Inc., 1948. 354 pp., illus. $3.50.

War work at the Massachusetts Institute of Technology included research and development contracts, including those carried out primarily by its staff, and larger projects for which the staffs were recruited from other institutions and organizations; special training courses; and personal services by its staff. This book is a history of M.I.T. during the war period, covering these categories, and is based on questionnaires to the staff, personal interviews, and information from published and other sources. It is well organized and indexed and is a useful addition to the growing list of histories of scientific and engineering accomplishment during the war.

The Army Air Forces in World War II. Volume I. Plans and Early Operations, January 1939 to August 1942. Chicago, University of Chicago Press, 1948. 788 pp., illus., maps. $5.00.

This is the first volume of a seven-volume history in preparation by the Office of Air Force History, under the editorship of Prof. Wesley Frank Craven, of New York University, and Prof. James Lea Cate, of the University of Chicago. While it was prepared with full official cooperation, it is the product of a group of professionally trained historians, organized during the war by the Historical Division of the A.A.F. for the purpose of preparing a comprehensive but manageable historical record. From the monographs and unit histories, with supplementary documents, resulting from this program, the cooperative preparation of the present history proceeded. The result is a volume by historians and bearing their interpretations and conclusions. It is well documented and indexed and marks the beginning of a reference source of permanent value.

Brassey's Naval Annual, 1948, edited by H. G. Thursfield. New York, The Macmillan Company, 1948. 583 pp., illus. $6.00.

The 59th annual volume of this British series contains Admiral Thursfield's annual naval survey, a review of naval air power, various documents relating to British naval defense, and selections from Admiral Nimitz' report. Over 450 pages are devoted to German documents on the conduct of the naval war from 1939 to 1945 under the title "Fuehrer Conferences on Naval Affairs."

Significant American and International Awards in Aviation. (U. S. Navy Department, Bureau of Aeronautics, Technical Information Branch.) Washington, July, 1948. 54 pp. Information is given on the origin and purpose, administrator, rules and regulations, selection board or committee, and lists of recipients and citations for about 50 awards.

Airborne Warfare. James M. Gavin. Washington, Infantry Journal Press, 1947. 186 pp., illus. $3.00.

The author was commander of the air-borne combat team that spearheaded the American assault of Sicily and led the assault parachute echelon division of the 82nd Airborne Division into Normandy, and, as a Major General, he commanded the division in Holland, Belgium, and Germany. He has provided an excellent account of air-borne actions during the war and a look into the future on parachute design, glider design, and transport design for air-borne troops. He believes that the highly developed troop-carrier transport and its accompanying escort, backed by large strategic airplanes, are essential to progress in air-borne warfare.

SCIENCES, GENERAL

MATHEMATICS

Analytic Theory of Continued Fractions. H. S. Wall. New York, D. Van Nostrand Company, 1948. 433 pp. $6.50.

The aim of the author is to present a unified theory of continued fractions in relation to analysis, requiring of the reader only a first course in function theory and a knowledge of the elementary properties of linear fractional transformations in the complex plane. A proof of Schwartz's inequality is included, as well as theorems on uniformly bounded families of analytic functions, properties of Stieltjes integrals, and an introduction to the matrix calculus. While a complete treatise is not attempted, the book deals with the theory of equations, orthogonal polynomials, power series, infinite matrices and quadratic forms in infinitely many variables, definite integrals, the moment problem, analytic functions, and the summation of divergent series. The arithmetic theory is not touched upon. A bibliography of 143 books and articles mentioned in the text is included.

MECHANICS

A Historical Appraisal of Mechanics. Harvey F. Girvin. Scranton, Pa., The International Textbook Company, 1948. 275 pp. $3.25.

This is a contribution to the growing body of literature on the history of science, principally because it is written by a teacher of engineering mechanics. Professor Girvin's purpose is "to put the essentials of the story of the growth and maturity of that portion of our scientific knowledge known as Mechanics—and its now virile offspring, Mechanics of Materials—into such readable form as to make it available to our young men and possibly stimulate their curiosity." The first half of the book deals with the period between 600 B.C. and the 18th century, embracing the work of Archimedes in the Greek period, Roger Bacon in the medieval period, and progressing through the Renaissance to Sevinus, Galileo, and, finally, Newton. This section ends with a chapter on the Bernouilli brothers, Euler, D'Alembert, Coulomb, and the later work of Lewis Poinsot on the theory of couples and the principle of conservation of energy. The second half of the book, on Mechanics of Materials, is the more valuable part. It consists of chapters on Pre-Elastic Development, the Theory of Elasticity, the Post Saint-Venant Period, Mechanics and Engineering Education in the United States, and the Nineteen-Forties. The author appears to be more at home with the topical arrangement, and his technical knowledge of the subject is turned to good account here. This period has been written about less, especially from the critical engineering point of view. Two useful chronologies and a bibliography are included as appendixes, and there is an author and a subject index. The author is a professor of mechanics at Purdue University.

STRESS ANALYSIS & STRUCTURES

Society for Experimental Stress Analysis, Proceedings, Vol. VI, No. 1. Cambridge 42, Mass., Addison-Wesley Press, Inc., 1948. 137 pp. $6.00.

Contents: An Investigation of the Stress and Strain States Occurring in Bending Rectangular Bars, by G. S. Sangdahl, E. L. Aul, and G. Sachs; A New Material for Three-Dimensional Photoelasticity, by M. M. Leven; Long-Time Electric Strain Gage Measurements on Concrete Reinforcing Rods at the Packard Proving Grounds Test Track, by F. L. Monchor, H. R. Lissner, and C. H. Lipson; Displacement Measurement by Mechanical Interferometry, by R. Weller and B. M. Shepard; Some Simplifications in the Numerical Solution of Laplace's Equation with Special Applications to Photoelasticity, by M. M. Frocht; A Direct Coupled Amplifier for Recording Dynamic Strain, by W. R. Mehaffey, J. N. Van Scoyoc, and D. S. Schover; Shock Testing Technology at the Naval Ordnance Laboratory, by J. H. Armstrong; A Photoelastic Study of Stresses in U-Shaped Members, by J. B. Mantle and T. J. Dolan; An Investigation of the Mechanical and Stress-Optical Properties of Columbia Resin, CR-39, by D. J. Coolidge, Jr.; The Photoelastic Laboratory at the Newport News Shipbuilding and Dry Dock Company, by Barron R. Lee, Roscoe Meadows, Jr., and Walter F. Taylor; Discussion of Above Paper, by A. J. Durelli; The Collapse of Long Cylindrical Shells under External Pressure, by Sidney Cornell; Studies of Transient Stresses in an Airplane Model Wing during Drop Tests, by O. N. Leal, R. L. Bisplinghoff, and T. H. H. Pian; The Equilateral Fleximeter, by Given Brewer; and The Interpretation into Stresses of Post-Yield Strains up to Two Percent, by J. Twyman.

THERMODYNAMICS

Elementary Thermodynamics. Virgil Moring Faires. Revised Edition. New York, The Macmillan Company, 1948. 268 pp., illus., diagrs. $4.40.

This revised edition of a textbook published in 1938 contains over 40 more pages and includes a number of revisions in the text, including a short discussion of the theory of the gas turbine in the chapter on Cycles for Internal Combustion Engines. Nearly all of the problems have been revised or replaced.

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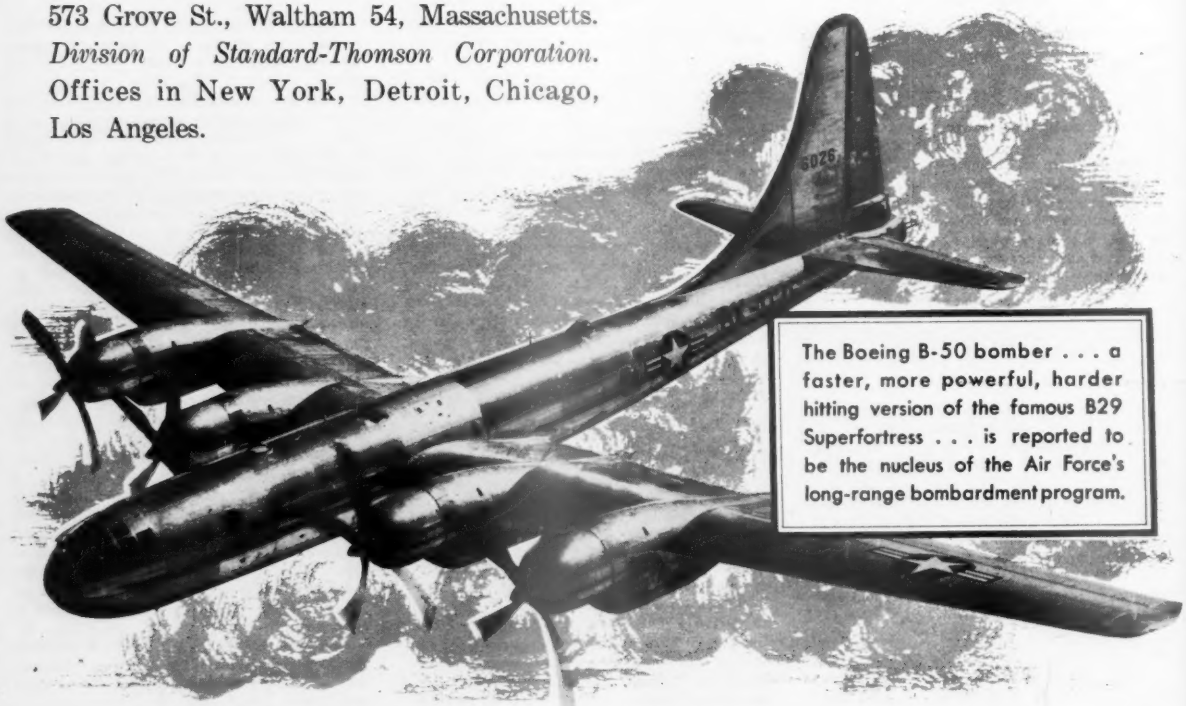

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I.A.S. Sections

(*Continued from page 14*)

fuselage that is 20 ft. 6 in. high, 14 ft. 3 in. wide, with a length of 182 ft. 6 in. indicates its inherent usefulness for transporting large bulky items over long ranges.

▸ **Problems Encountered**—Some of the design problems encountered in this airplane are worthy of note. The decision to use pusher propellers was partially influenced by a desire to provide an undisturbed airflow over the NACA 63 Series laminar flow type airfoil section and to reduce the fire hazard in the engine nacelles area.

Design of the main gear was changed from a single-wheel to a four-wheel individual gear. In the original design it was found that the load carried by each wheel was excessive and the airplane was restricted necessarily to only a few runways in the country. By replacing the single wheel with a group of four wheels, the available airports on which the XC-99 might land were increased, the braking effectiveness of the system was better, and the danger of accident from tire blowouts was reduced. In addition, the four-wheeled gear proved to be lighter than the original design, aiding greatly in keeping the weight of the plane at a minimum.

The nose gear was composed of two corotation wheels that prevented shimmy, so no damping device was required.

▸ **Magnesium in Wing**—Main structural material employed for the leading edge and trailing edge of the wing is magnesium, and the metal bond process is used to advantage for joining the members together. Mr. Hoover believes that this construction feature saved considerable weight in the airplane.

Flooring was a particularly difficult structural item to develop and various materials were considered before the final aluminum alloy structure was established. Various wooden structures were found to be unsatisfactory for steel wheel loads. It was interesting to note that a section of the fuselage was built up so that the frame might be load-tested. As the stress analysis of the frames was suspected to be conservative, the frames were deliberately made two gages lighter than necessary, and the test showed they were still adequate.

One further method for reducing the weight was by use of artificially aged aluminum-alloy parts. Also, 75ST parts were used wherever possible. Mr. Hoover mentioned that three processes—metal bonding, universal aging cycle, and anodizing magnesium—were developed to a high degree.

▸ **Cargo System**—Heavy cargo is stored in the lower deck and is loaded by use of a ramp; but lighter items of cargo are stored upon the upper deck. They are loaded entirely by use of hoists. The craneway rails on which the craneway beam travels do not extend the full length of the cargo area but instead are made of a short rail section only and travel upon rollers provided at each fuselage section. This saved considerable weight.

Mr. Hoover expressed the opinion that, if the required engineering talent is available, it would require approximately 2 years to design and build an airplane of the XC-99 type and that at the end of 1 additional year the plane could be ready for quantity production.

Philadelphia Section

J. Albert Roy, *Secretary*

Delos W. Rentzel was the principal speaker at the Section's meeting on September 30. His subject, "What C.A.A. Intends To Do for Aviation," was both interesting and informative.

▸ **No Mass Acceptance**—Among his remarks, the C.A.A. Administrator said that, although we know how to make 300-m.p.h. transports and 600 m.p.h. combat planes, our air lines currently are trying to fight their way out of the red ink at a time when most industries are prospering.

Also, Mr. Rentzel said, we have been working 45 years on aircraft, and have developed many wonderful technical features, yet we have been unable to put on the market a personal aircraft that could win mass acceptance and provide the basis for a thriving personal flying industry.

▸ **C.A.A. No Cure-All**—Mr. Rentzel stressed that the C.A.A. program does not purport to be a cure-all for the current difficulties of the aviation industry. Government alone, he said, cannot possibly furnish all the answers in this complex situation.

C.A.A. regulation, he went on, is carried on not for its own sake but for the purpose of promoting better standards. The higher the standards achieved, the less need for regulation. Hence, "our regulatory work will be successful only to the extent that it is self-liquidating."

▸ **Study Safety**—The entire field of safety is under study by the C.A.A., said the Administrator, because of the known significant part it plays in public acceptance of the airplane as a vehicle. While realizing there are many who feel that some of the regulations are too stringent and that there are too many regulations, Rentzel pointed out that, although the C.A.A. is charged with the enforcement of regulations, it is the C.A.B. who makes them.

Both agencies recognized the inherent weakness of the method—it is wrong in principle that the group that makes the regulations should also sit as judge, jury, and investigating agency over those who violate these same regulations.

▸ **New Legislation**—Recent legislation authorizes the C.A.B. to delegate to the C.A.A. authority to issue safety regulations, Rentzel said. It also provides that the C.A.B. can delegate to the C.A.A. authority to collect the facts in accident cases. From these facts, the C.A.B. would make its determination of probable cause.

Under the new plan, the C.A.A. would initiate and administer safety regulations and gather information concerning accidents. But every action would be subject to the scrutiny of an independent court—the C.A.B.—sitting in judgment on both the regulations and the details of the enforcement.

Saying that the C.A.A. welcomes recommendations and suggestions and citing instances in which such have been acted upon, Mr. Rentzel discussed the program of the Radio Technical Commission for Aeronautics for the development of air navigation and traffic control system to serve both military and civil users in peace or war. He concluded on the note that aviation is always changing and that C.A.A. will change with it.

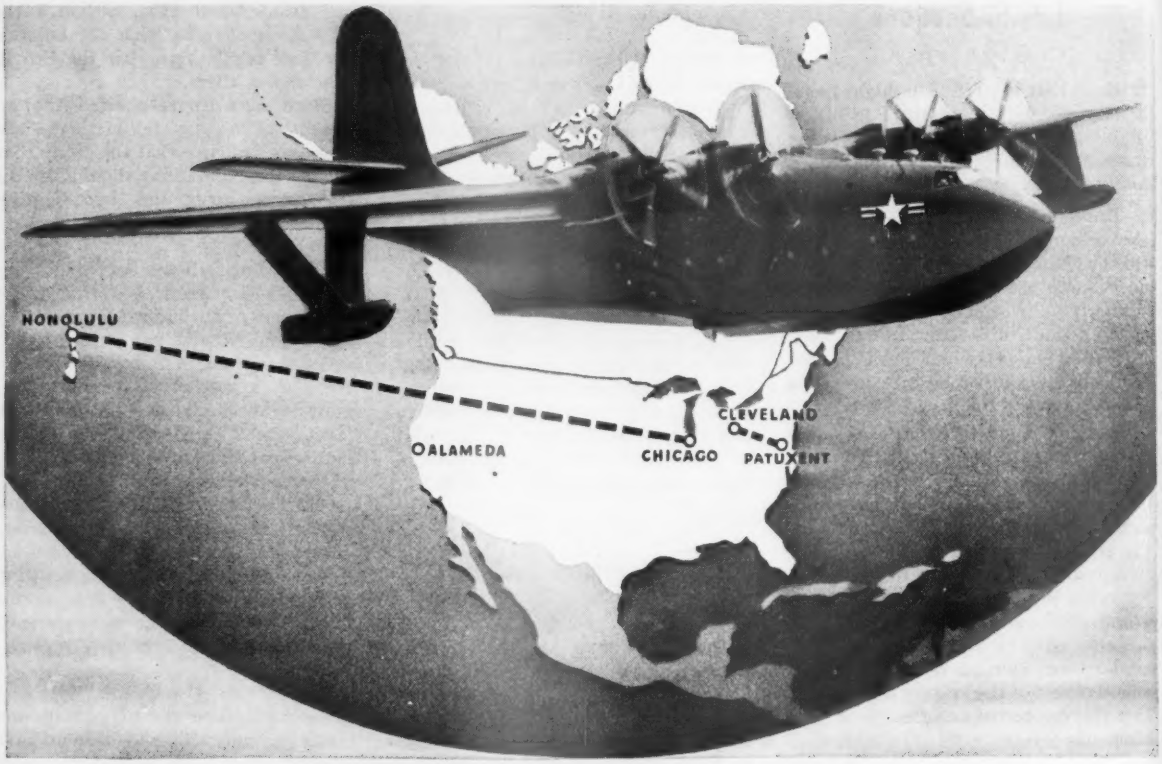
"We always will resist bureaucratic hardening of the arteries," he ended.

San Diego Section

W. T. Immenschuh, *Corresponding Secretary*

New officers were installed at the meeting of the Section September 23 as follows: Chairman, F. W. Fink, Consolidated Vultee Aircraft Corporation; Vice-Chairman, D. H. Bennett, Consolidated Vultee; Treasurer, R. L. Bayless, Consolidated Vultee; Corresponding Secretary, W. T. Immenschuh, Ryan Aeronautical Company; Recording Secretary, R. H. Schick, Consolidated Vultee. National Councilors: E. G. Stout, and Jack Mason, ex-officio, both of Convair; Leon Wosika, of Solar Aircraft, Area Councilor: Nominating Committee Member.

▸ **Seven Committees**—Members elected to seven committees included R. J. McCrea, Chairman, Meetings Committee; W. A. Clegern, Chairman, Program Committee; E. O. Baumgarten, Chairman, Publicity Committee; E. P. Rhodes, Chairman,



Martin MARS Writes the Future of Seaplanes in Today's Navy Records*

With a series of record-breaking flights, the Navy's new Martin JRM-2 Caroline Mars has refocused attention on the importance of seaplanes in modern military supply planning. And further emphasized the reputation of Martin flying boats for high performance, endurance and reliability! First the Caroline Mars cracked the non-stop seaplane record with a 4748-mile-flight from Honolulu to Chicago. A few days later, this mighty ship carried the highest airborne tonnage in history, flying 68,283 lbs. from Patuxent, Md., to Cleveland. Now, this latest Martin Mars is in service in the Pacific, regularly carrying 39,000 to 40,000 lbs. over the 2,400 miles from Alameda, Cal., to Honolulu!

Said Vice Admiral John D. Price, Deputy Chief of Naval Operations: "Squadron VR-2 with its 145,000-lb. JRM-1 flying boats has provided outstanding evidence of the significant role which large flying boats can play in meeting the logistic needs of national defense. Requiring no prepared forward bases . . . the flying boats can provide air lift in large tonnage volume with efficiency and economy of operation and complete mobility as to bases. Carrying even larger loads than its sister ships, the Caroline Mars will provide an important boost to the total air lift available in the Pacific."

It's another Martin "first" . . . building air power to save the peace, air transport to serve it!

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HONOLULU TO CHICAGO	4748 miles (plus 42 crewmen and passengers)	14,000 lbs.
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MANUFACTURERS OF: Marvinol resins (Martin Chemicals Division) • Martin 2-0-2 airliners • Advanced military aircraft • Revolutionary rockets and missiles • Aerial gun turrets • **DEVELOPERS OF:** Rotary wing aircraft (Martin Rotawings Division) • New type hydraulic automotive and aircraft brake • Mareng fuel tanks (licensed to U. S. Rubber Co.) • Honeycomb construction material (licensed to U. S. Plywood Corp.) • Stratovision aerial re-broadcasting (in conjunction with Westinghouse Electric Corp.) • **LEADERS IN RESEARCH** to guard the peace and build better living in many far-reaching fields.

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Builders of Dependable Aircraft Since 1909

Buildings Committee; Dick White, Chairman, Membership Committee; and K. R. Jackman, Chairman, Building Management Committee.

Members of the Management Advisory Committee are LaMotte T. Cohu; Earl D. Prudden, William C. Heath, Frank E. McCreery, and Henry I. Mandolf

▸ **Navy Speakers**—Speakers at the meeting were Comdr. E. P. Aurand, C.O., Fighting Squadron 51, and Lt. Comdr. R. M. Elder, Executive Officer, Fighting Squadron 51.

Commander Aurand presented some of the facts pertaining to the operation of FJ-1 jets, particularly discussing the problems of operating and maintaining jet aircraft aboard carriers.

Commander Elder discussed "Carrier Landing Techniques for Jet Aircraft," in which he explained the differences between landing jet and prop fighter aircraft.

Wichita Section

H. E. Dickard, *Secretary*

A dinner meeting was held September 16 at which the outgoing Chairman, Tom Salter, turned over the meeting to the incoming Chairman, Elton H. Rowley. Mr. Rowley introduced the new officers as follows: Vice-Chairman, J. H. Gerteis, Assistant Chief Engineer, Cessna; Secretary, H. E. Dickard, Design Engineer, Beech; and Treasurer, George W. Baughman, Project Engineer, Cessna.

▸ **Goodyear Trophy Racer**—An informal talk on the Goodyear Trophy Race was given by H. E. Bangerter, who piloted the racer designed by a group of University of Wichita senior students under the guidance of Prof. Kenneth Razak.

While he qualified for the final races, Bangerter was unable to compete because of illness. The procedures involved in the qualifying trials were described by the pilot. The Wichita University racer proved to have remarkably good control and stability characteristics, he said. In addition, its straightaway stall and turning high-speed stall characteristics are excellent, Bangerter declared.

▸ **Four Speakers**—At the October 7 meeting, a paper entitled "A Systematic Investigation of the Effects of Aspect Ratio, Taper Ratio, and Wing Section on the Charactistics of Tapered Wings" was presented in four parts by four senior students of Wichita University, with Professor Razak as Moderator.

Speakers were: Earl Keener, who gave Part I, which dealt with general methods of spanwise lift and drag distribution and basic equations involved; Earl Grandy, Part II, Airfoil Sections; Richard Wallace, Part III, Aspect Ratio; and Harold Lowe, Part IV, Wing Taper.

ACADEMY WINS LEAGUE PENNANT

In line with newly activated extracurricular program, the Academy of Aeronautics Branch of the Institute sponsored one of the softball teams of the school. Team, composed of William Richter; E. R. Pasquini; Byron R. Lerner; E. J. Alshut; W. J. Frank; J. Vincelli; Gino Olivier; Al Guido; L. Simmons; Stuart Pennypacker; and Robert Danton, with Philip E. Greenberg, Branch Secretary, as Manager, one of eight teams in the league, emerged as league champion. In photo (seated, left to right): Robert Danton; Phil Greenberg; A. Vizzino (not a Branch team member), winner of leading batter award; and Al Guido. Top row: Joseph Vincelli; Walter Frank; William Richter; Gino Olivier; Eugene Pasquini; Stuart Pennypacker; Linwood Simmons; and Joseph Liscouski, Faculty Adviser.

Student Branches

Academy of Aeronautics

Two meetings were held in September, on the 15th and 29th.

Chairman John P. Keilip opened the first meeting, which was devoted to business. Vice-Chairman Walter Theilhart gave a report on the program planned for the present semester, which included setting a new scholastic standard in order to raise the prestige of the branch.

A business session was held during the meeting on September 29.

Aeronautical University

The Branch held a meeting September 14 for the purpose of nominating candidates for officers for the coming semester.

Election of officers took place at the meeting held September 16 as follows: Honorary Chairman C. G. Sheker; Honorary Vice-Chairman, R. Fuqua; Chairman, William Lubach; Vice-Chairman, H. R. Henke; Secretary, M. M. Alison; Treasurer, M. Janoff; Sergeant-At-Arms, F. Sandberg.

Cal-Aero Technical Institute

At the September 14 meeting the following new officers were installed: Chairman, Albery Amaya; Vice-Chairman, James E. DeKlotz; Secretary-Treasurer, Fred Blechman.

Speaker for the day was Edward West, Jr., President of West Engineering Company, who explained how his firm was engineering the conversion of a G-E "Type B" turbosupercharger into a jet engine that could be produced for a fraction of the ordinary cost of such engines.

The October 12 meeting opened by Chairman Amaya was attended by 142 members and guests. The Chairman announced that, since the new Secretary-Treasurer Fred Blechman, was re-entering the Navy Air Service, Kenneth K. Mabuchi would take over the duties of that office. Approval by members was unanimous.

A talk on "Rocket Design Considerations" was given by Charles W. Cole, Chief Design Engineer, Jet Propulsion Laboratory, Cal-Aero Tech.

Catholic University of America

Election of new officers was held at the October 6 meeting. Results were as follows: Chairman, Marcian A. Herman; Secretary, James E. Moroney; Treasurer, Thomas M. Clancy.

Program and Refreshment committees were elected: for the Program Committee—James Alexander, Leonard Boegel, Woodrow Seamone, and Russell Johnson; for the Refreshment Committee—Walter Carrion, Percy Bobbitt, James Dutton, and Robert Taylor.

Illinois Institute of Technology

At the September 28 meeting of the Branch, Chairman Clifford D. Seidler mentioned the expansion of the Aeronautical Department with the aid of faculty advisers. Dr. Hawkins (Branch Faculty Adviser) explained the connections with the national organization through publications, etc.

The Chairman introduced Dr. Carvin newly appointed Chairman of the Mechanical Engineering Department, who spoke of the development and

definite place of the aero option in the Mechanical Engineering program.

Three Committees were appointed as follows: Program—Paul Margolis, Jerome Greenstein, Jack Behrand, Milt Weinberg; Membership—Bill Skene, Dan Fogg, Charles Marner; Publicity—Bill Furlong, Marvin Zelibor, Jim Smola.

Ohio State University

Guest speaker at the October 5 meeting was Lt. Col. Daniel F. Walker, Associate Professor, Department of Military Science, Air R.O.T.C. Branch, who gave a description of Air R.O.T.C. academic activities, including the recently formed aircraft maintenance subjects.

In addition, John Hulbert, Wind-Tunnel Project Engineer, gave orientations of project activities, with description and some technical data on the four supersonic wind tunnels now under construction at Don Scott Field, Ohio State University Airport, Columbus.

Professor Garvin L. von Eschen, head of the Aeronautical Engineering Department, presented information concerning present employment possibilities. He also elaborated on the importance of the I.A.S. publications for future reference.

Parks College of Aeronautical Technology

The Annual Engineering Banquet honoring the graduating engineers was held by the Student Branch on September 9. Guest Speaker was Otto E. Kirchner, Director of Engineering, Tulsa Maintenance Depot, American Airlines, Inc.

Mr. Kirchner presented the I.A.S. Scholastic Award to Paul Domanovsky for the best record in aeronautical engineering.

Mr. Kirchner then presented a paper on "Air Transport Modification" to the guests, which included Father Bischofberger, Regent of Parks College; Mr. Parks, Dean; Mr. Beck, Assistant Dean; Mr. Hertenstein, Head of Department of Maintenance Engineering; Messrs. Kneeland and Payne, American Airlines; and Mr. Barker, Honorary Chairman of the Branch. Mr. Kropf, Department of Aviation Head, was Toastmaster.

Oregon State College

At the September 29 meeting, a film, *The Construction of a Light Aircraft*, was shown. Curt Privett, Chairman, presided.

A social committee was appointed to make arrangements for an I.A.S. dance. Members included Elaine Gething, Wallace Vanboon, and Robert Paige. A Publicity Committee consisted of Warren Myllenbeck and Bob Neer.

University of Pittsburgh

An interesting U.S. Navy training film on *Lighter than Air Craft* was shown at the September 30 meeting. Chairman John L. Felix presided.

The film showed the history and development of the airship in Germany, England, and the United States during World War I and changes in design made in England and the U.S.

Rensselaer Polytechnic Institute

Lieutenant Commander D. S. Billings, of the U.S. Naval Helicopter Training School, Lakehurst, N.J., spoke on the aspects of Naval helicoper flight training at the October 7 meeting. Chairman Roger Donald Schaufele presided.

The Commander has flown all types of modern Naval aircraft and is presently engaged in helicopter pilot instruction.

University of Southern California

On September 24 the Branch held an organization meeting at which 25 prospective members applied for membership.

A general discussion future program covered the type of films wanted, the possibility of field trips, and a job survey program.

Tri-State College

The first meeting of the fall term was held September 29, Chairman Ernest E. Freund presiding.

Barrel-type wing and V-tail projects were discussed, and plans for final testing of these projects were made.

The Entertainment Committee planned to obtain films from the Institute Library. William Shaw, Chairman of the Committee, is assisted by committee members Paul Dnistran and Mr. Mendal.

Stewart Technical School

The following Meeting & Planning Committee members were elected at a meeting held September 1: Salvatore Cino and Thomas Daly. W. Blau presided as Chairman.

At the September 8 meeting two films were shown: *Report on Jet Propulsion* and *PBM-3 Wing Destruction Test.*

New I.A.S. members were welcomed to the Branch at the September 21 meeting by Mario D. Giovanni, Honorary Chairman, and on September 23 Samuel Woods, a student I.A.S. member, delivered a report on the procedure involved in setting up a scale model, to be tested in a wind tunnel, for computing lift, drag, and cross-wind forces.

Virginia Polytechnic Institute

At the October 5 meeting the Chairman, Herbert C. McClanahan appointed J. M. Eggleston and R. F. Wallace as representatives to the Student Engineering Council.

A slide rule was presented to V. W. Munsey by A. W. Robins, President of V.P.I. (Beta) Chapter of Gamma Alpha Rho, National Honorary Aeronautical Engineering Society, for having been the outstanding freshman in the Aeronautical Engineering Department of last year.

News of Members

(*Continued from page 15*)

Arthur M. Ogness, formerly Assistant Professor of Aeronautical Engineering, University of Illinois, is Structures Engineer, Douglas Aircraft Company, Inc., El Segundo, Calif.

Dr. W. Pfenninger is working as a Consultant Engineer in the Aerodynamic Laboratory of Sulzer-Brothers, Winterthur, Switzerland, on development of axial and radial fans. Sulzer-Brothers are working on turbojets for high-speed aircraft.

Jack M. Roehm is now with the Pullman Standard Car Manufacturing Company, Research & Development Department, Hammond, Ind. He formerly was with Buehler & Company, development engineers, in Chicago.

Allan M. Russell, former Consultant in New York City, is an official of Harris Calorific Company, Cleveland, Ohio, which produces oxygen regulators and welding, and cutting torches.

Arthur L. Shef is in California as Aerodynamicist "B," Douglas Aircraft Company, Inc. (Santa Monica), where he is working on guided missiles and aircraft.

Robert B. Sleight, formerly at Purdue University, has been appointed Research Associate in the newly organized Institute for Cooperative Research at The Johns Hopkins University. His work will include psychological aspects of instrument dial design.

Hugh H. Spencer, Manager of RCA Teleran Sales, Radio Corporation of America, received Presidential Certificate of Merit for his work as Chief of the Guided Missiles Division of the Office of Scientific Research & Development in the last war.

Edwin H. Spuhler is Sales Engineer, Forgings & Castings, Aluminum Company of America, Dallas District Office, Tex.

Robert A. Summers, formerly Assistant in Aeronautical Engineering, M.I.T., is Research Associate in the institution's Instrumentation Lab.

R. L. Thoren, Division Engineer—Flight Test, Lockheed Aircraft, believes less use will be made of the turboprop power plant than commonly thought. Speaking at S.A.E. meeting in Los Angeles, Thoren said 1955 transport would be straight jet.

David Thurlow has moved from Caldwell, Idaho, to Seattle where he is Designer "A," Boeing Airplane Company.

Joseph L. Velazquez has joined Piasecki Helicopter Corporation as Design Engineer in Charge of the Structural Design Group late in October. He was at North American Aviation in Charge of Loads and Design Criteria for Navy Projects, serving as Structures Engineer. He is a former Navy officer and a graduate of Cal Tech.

Robert K. Wattson, Jr., is Assistant Professor of Mechanical Engineering (Aeronautics) at the North Dakota Agricultural College. He received the M.S. Degree from Massachusetts Institute of Technology in August.

Paul H. Wilkinson, Editor of *Aircraft Engines of the World*, reports Russian Yak fighter buzzing Berlin airlift transports is powered by engine known as AM-12, a 12-cylinder V-type liquid-cooled inline power plant with two-speed supercharger that is gear-driven. Take-off rating, he says, is 2,000 hp., about 250 hp. under Allison V-1710 powering F-51. AM-12 was developed from Curtiss Conqueror and German engine, Wilkinson added.

Benjamin W. Wyche is a Patent Examiner for the U.S. Commerce Department; he was with the American Car & Foundry Company, Berwick, Pa., as Designer and Draftsman. He now lives in Emporia, Va.

Necrology

G. W. Krebs

Project pilot on the B-45, George W. Krebs, a North American Aviation Engineering Test Pilot, was killed last September in the crash of the B-45 jet bomber he was testing near Alpaugh, Tulare County, Calif. With him in the crash was Nicholas Pickard, also an I.A.S. Member and North American Test Pilot.

▶ **First to Fly Multiple Jet**—George Krebs was the first pilot in America to fly a multiple-jet aircraft (the B-45). He learned to fly in 1935, earning his private pilot's license at the Lincoln Flying School, Lincoln, Neb.

In the fall of that year he entered the School of Aeronautical Engineering at Massachusetts Institute of Technology, where he studied for 3 years. Twelve years after he learned to fly, Krebs flew the B-45 on March 17, 1947.

▶ **Kept Flying**—During his college years, he kept flying, and in 1937 he bought a five-place Waco, which he used to fly his father on business trips and for charter flights. He became Luscombe distributor in Kansas City, continuing until the beginning of the war.

Krebs went to Pan American Airways-Africa Ltd. as Senior Pilot, flying over Africa, the Middle East, and India, in 1942, participating in the aerial evacuation of India, and then joined North American (Kansas plant) as Test Pilot January 1, 1943. He was Chief Test Pilot since March 1944, doing most of the engineering and experimental flight work at the Kansas City plant thereafter.

In July, 1945, he was transferred to the parent plant in Los Angeles as Engineering Test Pilot.

Born on March 5, 1918, Mr. Krebs is survived by his wife, Mrs. Alice Krebs, and two children, William John and Charlotte Anne, 4 and 2, respectively.

Nicholas G. Pickard

Together with George Krebs, Nicholas G. Pickard, 32, was killed in the crash of the B-45 jet bomber late last September.

A newcomer at North American Aviation, where he was Engineering Test Pilot, Mr. Pickard was only recently elected a Member of the Institute, in July, 1948.

▶ **Excellent Pilot**—Described by George Krebs as "one of the finest all-round pilots in the world," who had flown all operation single- and twin-engined aircraft made by the U.S. and Great Britain during the war while with the British Air Transport Auxiliary, "Nick" Pickard was born in Brooklyn, N.Y., in November, 1916.

Obtaining a B.S. in General Engineering at Massachusetts Institute of Technology in 1940, he joined Transcontinental & Western Air, Kansas City, as Maintenance Engineer, where he remained until he joined the Air Transport Auxiliary in England.

Subsequently, he transferred to the R.A.F. Transport Command at Montreal, Quebec, ferrying and operating military transport aircraft on North, South, and Central Atlantic trips. He was one of the few pilots who was capable of (and usually preferred) doing all his own navigation, including celestial, and he set many records for frequency and speed of his trips.

▶ **T.W.A. Test Pilot**—In the last group of civilian pilots released, well after VJ-Day, he returned to T.W.A. as an Engineering Test Pilot, where the company found his engineering background and scientific approach extremely valuable.

It was Krebs who was largely responsible for his going to North American, where he did engineering test work on nearly all of the company's aircraft.

He is survived by his wife, Mrs. Kathleen Pickard, and two children, Sandra, 2 years, and Manya, 5 months.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Elected to MEMBER Grade

Ashworth, C. Dixon, B.S. in Ae.E., Project Mgr., 7 by 10 ft. Sonic Wind Tunnel, David Taylor Model Basin (Washington, D.C.).

Carter, Wilbert Vernon, Aerodynamicist "A," Consolidated Vultee Aircraft Corp.

Collins, Thomas W., Jr., B.S., Comdr., U.S. Navy; Assigned to Aero. Engineering duty.

Emley, Warren E., Jr., B.S.M.E., Aero. Research Scientist, N.A.C.A. (Cleveland).

Fung, Yuan-cheng, Ph.D., Instructor, California Institute of Technology.

Gustafson, Harry Fred, Designer "A" & Leadman, Fuselage Group, Douglas Aircraft Co., Inc. (El Segundo).

Keller, William Carl, B.S. in M.E., Asst. to Chief Engineer, Consolidated Vultee Aircraft Corp.

Lowry, John G., B.S. in M.E. (Aero.), Group Leader of Aero. Research Scientists, Langley Mem. Aero. Lab., N.A.C.A.

Monroe, Gerald Morgan, Lt. & Naval Aviator; Designated for Aero. Engineering Duty only, U.S. Navy.

Roberts, Edward E., A.B., Weights Group Engineer, Consolidated Vultee Aircraft Corp.

Spurr, William Frederick, Chief, Aircraft Branch, British Joint Services Mission (T.S.).

Stanley, Max R., Engineering Test Pilot, Northrop Aircraft, Inc.

Trussell, James Irwin, B.S. in Ae.E. & M.E., Design Specialist, The Glenn L. Martin Co.

Whyatt, Norman Russell, Technical Officer, Royal Insurance Co., Ltd., & Liverpool & London & Globe Insurance Co., Ltd.

Wise, Jowell C., Major, U.S.A.F.; Chief, Flight Development Section, Muroc Air Force Base.

Transferred to MEMBER Grade

Archer, Harry C., B.S. in M.E. (Aero.), Instrument & Electrical Engineer, National Airlines, Inc.

Ceccarelli, John F., B.S. in Ae.E., Structures Engineer, Electrol, Inc.

Fleisig, Ross, B. of Ae.E., Lead Aerodynamicist, Chance Vought Aircraft Div., United Aircraft Corp.

Gasich, Welko Elton, Ae.E., Lead Man, Stress Group, Douglas Aircraft Co., Inc.

Gopper, Jean Glen, M.S. in A.E., Capt., U.S.A.F.; Project Engineer, 10 Ft. High Speed Wind Tunnel (Wright Field).

Green, Alan Harte, B. of Ae.E., Graduate Student in Aeronautics, California Institute of Technology.

Howard, Ephraim M., M.S.E. in Ae.E., Aero. Engineer, N.A.C.A. (Cleveland).

Lombardo, Thomas Peter, B. of Ae.E., Chief Engineer, Pioneer Air Lines, Inc.

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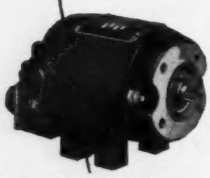
an advantage of special application

Lamb Electric MOTORS



Compactly designed motor developed for metering pump and special instrument service.

● Lamb Electric Motors are *specially designed* for a specific application and therefore provide the exact electrical and mechanical characteristics for each product they drive.

In addition to this important advantage, other basic factors that contribute to the superior performance of Lamb Electric Motors are thorough engineering, exacting manufacture and rigid testing.

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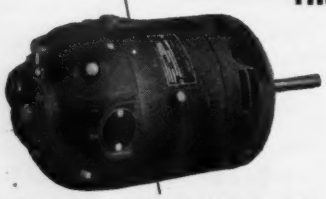
KENT, OHIO



This motor is used extensively on such products as: industrial cleaners, agitators, sirens and colloid mills.

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Lamb Electric SPECIAL APPLICATION FRACTIONAL HORSEPOWER MOTORS

Lowy, Stanley Howard, M.S. in Ae.E., Instructor, Aero. Engineering, Oregon State College.

Martin, Harry Edwin, B.S., Aerodynamicist, Aerodynamics Section, Douglas Aircraft Co., Inc.

Miller, Jack Naylor, M.S. in Ae.E., Lt., Guided Missile Project Officer, Naval Air Material Test Center, Pt. Mugu.

Miller, Kenneth Dexter, Jr., M.S. in Engineering, Project Engineer, Princeton University.

Parchem, John Anthony, B.S. in Ae.E., Asst. Professor of Aero. Engineering, University of Notre Dame.

Riley, Claude Frank, Jr., B.S. in G.E. (Aero.), Research Assoc., University of Michigan Aero. Research Center.

Sacks, Alvin Howard, B.S. in Ae.E., Candidate for M. of Ae.E. Degree, Cornell University.

Stuth, Wilfred H., B.S. in Ae.E., Wind Tunnel Operator & Aerodynamicist, Southern California Cooperative Wind Tunnel.

Elected to Associate Member Grade

Getz, Richard Arthur, Chief, Design Section, Marquardt Aircraft Co.

Lyche, Webster N., Technical Adviser & Mgr., Sp"AIR"es, Inc. & Aircraft Engineers Association.

Olshan, Calvin Vincent, Commercial & Application Engineer, Aviation Div., General Electric Co.

Whitlock, Allen, School Director, Rising Sun School of Aeronautics.

Elected to Technical Member Grade

Albano, Domingo Pedro Numa, Ae.E., Technical Representative (Western U.S.), Flota Aerea Mercante Argentina.

Arnold, William Jackson, Engineering Draftsman, Eldred Development Corp.

Davenport, Edwin E., B.S. in M.E., Aero. Engineer P-1, Free Flight Tunnel, N.A.C.A. (Langley Field).

Hove, John Edward, Jr., B.S. in Ae.E., Assoc. Engineer, Cornell Aero. Lab.

Kahn, Harry J., B. of Ae.E., Chief Structural Engineer, Gassner Aircraft Engineering.

Kretsinger, Stanley L., Jr., Production Planner—Detail & Assembly, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Magnusson, Rolf C. G., Projecting Engineer, Royal Swedish Air Board (Sweden).

Maier, Henry Gert, S.M., Teaching Fellow, Graduate School of Engineering, Harvard University.

Mayers, Jean, M. of Ae.E., Aero. Research Scientist, N.A.C.A., (Langley Field).

Medlin, Wilbur Keith, A.A. in Ae.E., Layout & Design Engineer, Hamilton Standard Propellers Div., United Aircraft Corp.

Mooradian, Albert Haig, Layout Man, Engineering Dept., The Glenn L. Martin Co.

Moore, Frederick T., B.A.Sc., Sr. Engineer, Engineering Dept., Trans-Canada Air Lines.

Tysklind, Hans, Project Engineer, Royal Swedish Air Board; Teaching Engineer, Stockholms Tekniska Institut.

Transferred to Technical Member Grade

Acheson, Duane Bernard, B.S. in Ae.E., Engineer, Wing & Body Structural Group, Boeing Airplane Co. (Seattle).

Ahler, Daniel Butler, Jr., Aircraft Maintenance Technician, Air National Guard (Kentucky).

Armstrong, William Franklin, Jr., B.S., Design Detailer, McDonnell Aircraft Corp.

Baldwin, Floyd Lee, B.S. in Ae.E., Jr. Engineer, Boeing Airplane Co. (Seattle).

Barranger, Robert Davis, B.S.

Baylor, Elwood Paul, A.A. in Ae.E., Draftsman, Lee C. Moore Corp.

Beggs, John C., B.S. in Ae.E., Engineer, Hamilton Standard Propellers Div., United Aircraft Corp.

Bowles, Carey Edward, Jr., B.S., Mgr., Bowles-Davis Flying Service, Inc.

Bray, William G., Jr., B. of Ae.E., Instructor, Rensselaer Polytechnic Institute.

Brockette, Willard N., B.S. Ae.E.

Brubaker, Alvin Galen, B.S. in Ae.E., Sr. Detailer, McDonnell Aircraft Corp.

Bryant, Billy V., A.A. in Ae.E., Aero. Engineer, Design Dept., McDonnell Aircraft Corp.

Burke, Joseph Edward, B.Ae.E., Jr. Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Christensen, James Eugene, B.S., Major, U.S.A.F.; Buyer and/or Project Engineer, Hq., Air Materiel Command (Wright-Patterson Air Force Base).

Christopher, John Francis, S.B. in Ae.E., Jr. Aerodynamicist, The Glenn L. Martin Co.

Clements, Robert Roy, B.Ae.E., Jr. Aerodynamicist, Wind Tunnel Dept., Cornell Aero. Lab.

Connor, Thomas Cotter, B.S. in Ae.E.

Cotton, Richard Hugh, Flight Test Analyst, Lockheed Aircraft Corp.

Cowdin, Paul Earl, B.S. Ae.E., Jr. Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Cronin, John Ellsworth, B.S. in Ae.E., Draftsman & Jr. Engineer, Aeroproducts Div., General Motors Corp.

Damman, Floyd Frederick, B.S., Engineering Draftsman, Northrop Aircraft, Inc.

Defosse, John F. E., B.A.Sc., Asst. Research Officer, National Research Council (Canada).

Diggins, James Louis, B.A.E., Aero. Engineer, Naval Ordnance Lab. (White Oak, Md.).

Domanovsky, Paul, B.S. in Ae.E., Graduate Student, St. Louis University.

Dugundji, John, M.S. in Ae.E., Aero. Research Engineer, Grumman Aircraft Engineering Corp.

Eggert, Carl Albert, B.S. Ae.E.

Eisenberg, David, Engineering Draftsman "A," Hughes Aircraft Co.

Ericksen, Walter Preston, A.A. in in Ae.E., Draftsman, American Airlines System.

Eskilson, Jack E., B.S., Sr. Detailer, McDonnell Aircraft Corp.

Ferguson, Charles William, B.S. in Ae.E., Mathematician "A," Strength Analysis Group, Douglas Aircraft Co., Inc. (Santa Monica).

Fikes, Joseph Edward, B.S. in Ae.E., Aero. Engineer, N.A.C.A. (Langley Field).

Fisher, Jack Warren, B.S.Ae.E., Weight Estimator, Boeing Airplane Co. (Wichita).

Fiteny, Louis Michael, B.S.E. (Aero.), Engineer, Hamilton Standard Propellers Div., United Aircraft Corp.

Fyfield, Herbert Stanley, Jr., B. of Ae.E., Engineer, Boeing Airplane Co. (Seattle).

Gallagher, John Vincent, B.Ae.E., Product Designer, Thompson Products, Inc.

Gapcynski, John Paul, M.Ae.E., Aero. Research Scientist, Langley Mem. Aero. Lab., N.A.C.A.

Gogan, Harry Leo, B.S. in Ae.E., Aero. Engineer P-1, Langley Mem. Aero. Lab., N.A.C.A.

Gordon, Robert Cameron.

Green, Howard, S., B.S. in A.E., Jr. Stress Analyst, Structural Test Dept., The Glenn L. Martin Co.

Hardwick, George C., B.S., Jr. Engineer, Products Div., Bendix Aviation Corp.

Hayes, Clyde, B.Ae.E., Aero. Engineer P-1, Compressibility Research Div., Langley Mem. Aero. Lab., N.A.C.A.

Heinle, Donovan Ralph, B.S., Aero. Engineer, N.A.C.A. (Moffett Field).

Heisler, David, Sr. Draftsman, Goodyear Aircraft Corp.

Hilton, John H., Jr., B.Ae.E., Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Hine, Louis Joseph, B. of Ae.E., Aero. Research Engineer, N.A.C.A. (Langley Field).

Holzhauer, Earl John, B.S.A.E., Jr. Engineer, Structural Test, Boeing Airplane Co. (Seattle).

Irwin, Ward James, B.S.E. (Aero.), Jr. Engineer "B," Boeing Airplane Co. (Seattle).

Karwoski, John Stanley, B.Ae.E.

Kestenberg, Henryk, A.A. in Ae.E.

Lamour, Warren Stanley, B.Sc., Research & Development Engineer, Goodyear Aircraft Corp.

Mabry, Irvin Charles, B.S. Ae.E., Steel Blade Development Engineer, Hamilton Standard Propellers Div., United Aircraft Corp.

Mavricos, Marios Paul, B.A.E., Jr. Stress Analyst, The Glenn L. Martin Co.

McComb, Harvey G., Jr., B.S. in Ae.E., Graduate Teaching Asst. & Student, Purdue University.

McGuigan, Mortimer J., Jr., B.S., Jr. Asst. Aero. Engineer, N.A.C.A. (Langley Field).

McIndoo, Walter J., B.S., Flight Lt., Aero. Engineer, Royal Canadian Air Force.

Medick, Matthew Anthony, B.S. Ae.E., Graduate Asst. in Mathematics, University of Maryland.

Mock, Wendell D., B.S. Ae.E., Structural Test Engineer, North American Aviation, Inc.

Montanino, Louis, B.S.

Moomaw, Howard, Jr., B. of Ae.E., Jr. Engineer, Curtiss-Wright Corp. (Columbus).

Moore, John A., B.S. in Ae.E., Aero. Engineer P-1, N.A.C.A. (Langley Field).

Morris, Owen Glenn, M. of Ae.E., Aero. Research Scientist P-2, N.A.C.A. (Langley Field).

Mulac, Joseph A., B.S. Ae.E., Layout Man, Bethlehem Steel Co.

Norman, Robert I., Jr., S.B., Jr. Aerodynamicist, Wind Tunnel Group, The Glenn L. Martin Co.

Ohrman, Clyde William, B.S. in Ae.E., Jr. Engineer "B," Boeing Airplane Co. (Seattle).

Olson, William LeRoy, B. of Ae.E., Jr. Aerodynamicist, Wind Tunnel Group, Cornell Aero. Lab.

Ondrejka, Joseph, B.S.A.E., Aero. Research Development & Design Engineer, Air Materiel Command (Wright Field).

Onspaugh, Carl M., B.S. in Ae.E., Jr. Engineer, Equipment Group, Airplane Div., Curtiss-Wright Corp.

Peterson, Robert L., B.S., Research Analyst "B," Consolidated Vultee Aircraft Corp. (Ft. Worth).

Pittman, Walter D., B. of A.E., Stress Analyst, McDonnell Aircraft Corp.

Pound, Alan Garrett, B.S.E. (Aero.), Jr. Test Engineer, The Glenn L. Martin Co.

Radhakrishnan, S., S.M.

Redmond, Richard Elmer, Engineering Draftsman "B," Northrop Aircraft, Inc.

Rowe, James Russell, B.S. in Ae.E., Instructor, Theoretical & Applied Mechanics Dept., Iowa State College.

Russell, Thomas Edwin, B.S. Ae.E., Sr. Draftsman, Goodyear Aircraft Corp.

Rustemeyer, Ashton H., B.Ae.E., Research Engineer, United Aircraft Corp.

Scheuing, Richard Albert, S.B. & S.M. in Ae.E., Research Engineer, Grumman Aircraft Engineering Corp.

Schier, Joseph Francis, A.A. in Ae.E., Asst. Stress Analyst, McDonnell Aircraft Corp.

Schmidt, Franklin Robert, Jr., B.S. in Ae.E.

Schreiber, I. Carl, B.S. Ae.E., Service Engineer, Beech Aircraft Corp.

Stark, Warrington Bates, B. of Ae.E., Aero. Engineer, United Aircraft Corp.

Tietzel, Frederick A., B.S.Ae.E.

Toy, Harrison W., A.A. in Ae.E., Draftsman, The Budd Co.

Tydeman, Stephen F., B.S. in Ae.E., Flight Test Engineer, Douglas Aircraft Co., Inc.

Tymczyszyn, Joseph J., B.S. in Ae.E., Flight Test Engineering Pilot, C.A.A. (Kansas City Region).

Watts, George Wilson, B.S. A.E., Jr. Test Engineer, Wright Aero. Corp. Div., Curtiss-Wright Corp.

Weatherwax, William Francis, B.S.E. (Aero.), Jr. Engineer, Wright Aero. Corp. Div., Curtiss-Wright Corp.

Welch, Kenneth Eugene, B.S. in Ae.E., Aero. Engineer P-1; N.A.C.A. (Cleveland).

Werback, William John, M.E., Engineering Asst. "A," Consolidated Vultee Aircraft Corp.

Wright, William Thomas, B.Ae.E., Engineering Trainee, Chance Vought Aircraft Div., United Aircraft Corp.

Yonan, Arthur, B.S.A.E.

Announcing a New Journal Department . . . Readers' Forum

It has been suggested by several members of the I.A.S. Editorial Committee that the *Journal* open a special department to fill the need for the more immediate communication of essential results of research in the greatly expanded and accelerated fields of the aeronautical sciences. Therefore, it has been decided to establish a new department, the "Readers' Forum," which will include letters to the editor for the quick publication of (1) brief reports of important findings in aeronautical sciences and (2) discussions of papers published in the *Journal*.

Specifications for Submission of Material

(1) All letters should be accompanied by a suggested short title, giving some indication to the reader of the subject under discussion.
(2) These letters should not exceed 800 words in length.
(3) Publication will be completed 6 to 8 weeks after receipt of the material.
(4) The Editorial Committee will not hold itself responsible for the opinions expressed by the correspondents, and no proofs will be sent to the authors.
(5) All letters should be double-spaced.

The new department will be started with the January, 1949, issue of the *Journal*. Contributions should be sent to:

Editor, Journal of the Aeronautical Sciences
2 East 64th Street
New York 21, New York

I.A.S. National Meeting Schedule

Wright Brothers Lecture—U.S. Chamber of Commerce Auditorium, Washington, D.C.—December 17, 1948

Seventeenth Annual Meeting—Hotel Astor, New York, N.Y.—January 24-27, 1949

Members or organizations wishing to submit papers for presentation at National Meetings should send outlines or summaries to the Committee at least 3 months prior to the meeting.

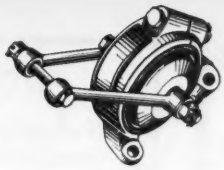
All papers submitted will be considered for publication in the *Journal of the Aeronautical Sciences* or the *Aeronautical Engineering Review*.

All correspondence should be addressed to The Meetings Committee, Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

RS-40G ASSEMBLY

[Consists of six RS-40G-SA sub-assemblies]

For LOCKHEED "CONSTELLATION"
DOUGLAS AD-1 & AD-2
MARTIN "MARS" (JRM-1)
Using Wright R-3350-C18BB and C18BD Engines



RL-35 ASSEMBLY

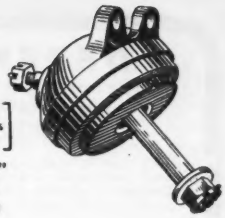
[Consists of nine RL-35-SA sub-assemblies]

For LOCKHEED "CONSTELLATION" Using Wright R-3350 A & B Series Engines

MR-36 and MR-36F ASSEMBLIES

[Consist of six MR-36-SA; six MR-36F-SA sub-assemblies respectively]

For CONSOLIDATED "240"
CURTISS CW-20 (C-46)
DOUGLAS DC-6 (C-112)
MARTIN 202



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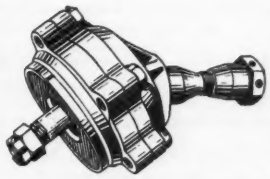
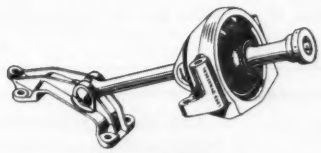


MR-26 ASSEMBLY

[Consists of eight MR-26-SA sub-assemblies]

For DOUGLAS DC-4 (C-54)
Using Pratt & Whitney R-2000 Series Engines



MR-40D ASSEMBLY

[Consists of seven MR-40D-SA sub-assemblies]

For BOEING 377
BOEING B-50
DOUGLAS C-124
MARTIN P4M1
MARTIN AM1
FAIRCHILD C119

LORD ENGINE MOUNTINGS for DC-3

Item	P&W 1830 Series Quantity Per Plane	P&W 1830 Series Part Number	Wright 1820 Series Quantity Per Plane	Wright 1820 Series Part Number
Tube Mounting	8	J 1202-1	8	H5013-3
Insert	16	J 1789-1	18	SK1925-1
Sandwich	32	SK1292-1	36	SK1292-2

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Structures Engineer: For preliminary design group studying new types of aircraft. Four to five years' experience in stress analysis and structural design required. Advanced degrees with two or three years' experience acceptable. Should be thoroughly familiar with analysis of all major components of airframe.

In reply, please give resume of personal qualifications, education, experience and salary to NEPA DIVISION, Fairchild Engine and Airplane Corporation, Post Office Box 415, Oak Ridge, Tennessee.

Personnel Opportunities

This Section is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute

WANTED

Aircraft Dynamics Engineers—For research work on subsonic and supersonic flutter, vibration, dynamic loads, stability and control of supersonic missiles, and helicopter dynamic problems. Applicants must have good background in fundamentals of applied mechanics and mathematics. Advanced degree or previous experience in field is essential. Salaries commensurate with training and experience. Cornell Aeronautical Laboratory, Employment Office, 4455 Genesee St., Buffalo 21, N.Y.

Chief Engineer—Sales Manager—To head engineering and sales of long-established company manufacturing aircraft fuel, oil, air, and water injection pumps, valves, etc. Must be experienced in design and manufacture of these products, be conversant with Air Force and Navy requirements, and have good knowledge or experience in application or sale of these products. Company has good staff but needs to supplement this with aggressive, experienced, top-grade pump engineer. Excellent prospects for profitable future. On initial application please give complete information, including former employers, duration of employment, responsibilities, name of immediate supervisor, salary, etc. Reply Lear, Incorporated, Romec Pump Company Division, Elyria, Ohio; Attention: J. H. Lyons.

Helicopter Engineer—Experience in helicopter aerodynamics and stress analysis required. Apply in writing with a résumé of experience and education to American Helicopter Company, 900 N. La Brea Ave., Inglewood, Calif.

Aircraft Engineers—Opportunities for research and development on the B-36, world's largest bomber, and other heavy aircraft, at Convair's Fort Worth Tex., Division. Experienced engineers needed now in these classifications: Aerodynamicists, Engineering Designers, and Engineering Draftsmen. Send complete summary of training and experience to Engineering Personnel Office, Consolidated Vultee Aircraft Corporation, Fort Worth, Tex.

Structural Designers—Engineers experienced in design of sheet-metal structures desired for large cargo aircraft project. Graduate engineers preferred. All r plies held confidential. Write, Project Engineer, Chase Aircraft Company, Inc., West Trenton, N.J.

Layout Draftsmen—Six or more years' experience in aircraft layout and design. Cargo aircraft experience desired. Graduate engineers preferred. All replies held confidential. Write, Project Engineer, Chase Aircraft Company, Inc., West Trenton, N.J.

Stress Analysts—Personnel with experience on sheet-metal, monocoque, cargo-type aircraft desired. Graduate engineers with 5 or more years' experience preferred. All replies held confidential. Write, Project Engineer, Chase Aircraft Company, Inc., West Trenton, N.J.

Research Aeronautical Engineer—Engineering graduate with good command of physics and mathematics, to assist in the conduct of ballistic research. Excellent opportunity to obtain research experience and advanced degree. Address reply to D. W. Dutton, Director, Daniel Guggenheim School of Aeronautics, Georgia Institute of Technology, Atlanta, Ga., giving full particulars. Salary open.

Engineers—Rotary Wing—Now engaged in C.A.A. certification. Unlimited opportunities for qualified stress analyst, flight-test engineer, detail and layout draftsmen. Opening as Chief Engineer to take charge of certification work. Write full particulars to Jensen Helicopter Company, Inc., Tonasket, Wash.

Aeronautical Engineer—A position is available in the Research and Development Group of the Naval Bureau of Aeronautics in Washington, D.C., for an Aeronautical Engineer preferably with a background in electronics. Duties will involve research and development program planning and related tasks of justification presentation and analysis. Ability to express complex thought in clear readable fashion essential. This position is under Civil Service and will command a salary of $6,235 per annum. Address: Personnel Division, Bureau of Aeronautics, Department of the Navy, Washington, D.C.

Aeronautical Engineers—The U.S. Naval Air Station, Quonset Point, R.I., has announced a probational examination for Aeronautical Engineer (Power Plants) $4,479 a year, and Aeronautical Engineer (General) $4,479 to $7,432 a year. This examination will be used to fill future vacancies occurring at the Air Station and at other Federal Agencies throughout the New England states. Applications are being accepted until further notice. Write to Recorder, Board of U.S. Civil Service Examiners, U.S. Naval Air Station, Quonset Point, R.I., for further details.

Flutter Engineer—Aeronautical Engineering graduate with several years of experience in flutter and vibration problems for work on advanced military aircraft. Address reply to Engineering Personnel Office, North American Aviation, Inc., Municipal Airport, Los Angeles, Calif.

Preliminary Design Engineer—The Agricultural and Mechanical College of Texas, Department of Aeronautical Engineering, has an opening for a man to teach preliminary design and participate in aeronautical research. Facilities include large wind tunnel, excellent paved airport, and flight-research equipment. Rank and salary dependent on training and experience of applicant. Edward E. Brush, Department of Aeronautical Engineering, A. & M. College of Texas, College Station, Tex.

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Engineers and Scientists—The Navy Department is seeking engineers and scientists in practically every field for employment in Washington, D.C. Specific vacancies exist for aeronautical, civil, electrical, electronics, industrial, marine, and mechanical engineers, and for mathematicians, Naval architects, physicists, and others, with salaries ranging from $2,974.80 to $10,330. Some of the positions involve occasional travel to Naval Shore Establishments for the purpose of observing or participating in scientific tests of Naval equipment. Others require original research or planning scientific programs. All of the positions are concerned with the most recent advancements in the scientific field. Applications for the positions should be made on Standard Form 57, available at any first- or second-class Post Office, and should be mailed to Code 612, Room 1213, Main Navy Bldg., 17th and Constitution Ave., Washington, D.C.

Electrical and Aeronautical Engineers—Corporation engaged in development of aircraft remote control and telemetering equipment has need for engineers of several categories: (1) Young graduate electrical engineers having good background in electronics and communications. (2) Graduate electrical engineers with experience in electronics and communications. (3) Graduate electrical or mechanical engineers having background in servomechanism design. (4) Aeronautical engineers having experience in stability and control. Wing Engineering Corporation, Colonial Bldg., Philadelphia 7, Pa.

Aerodynamicists and Aeronautical Engineers—Positions available for highly qualified technical personnel with good theoretical or experimental background to engage in development of facilities and model test work in stability, control, high-speed, and supersonic aerodynamics. Projects include new models of piloted and pilotless aircraft, new wind tunnels and associated equipment, and advanced testing techniques. Salary in accordance with qualifications and Civil Service regulations. In reply, please give summary of personal qualifications, education, and experience. Address—Director, David Taylor Model Basin, Washington 7, D.C.

907. Engineering Administrator—For instrument development laboratory in New York Metropolitan area. Experience on design, development, and manufacture of aircraft instruments, telemetering equipment, and servomechanisms desirable. Own engineering talent less important than ability to organize and direct others. Salary: $6,000 to $10,000.

The number preceding the notices represents the Box Number of the Institute of the Aeronautical Sciences to which inquiries should be addressed.

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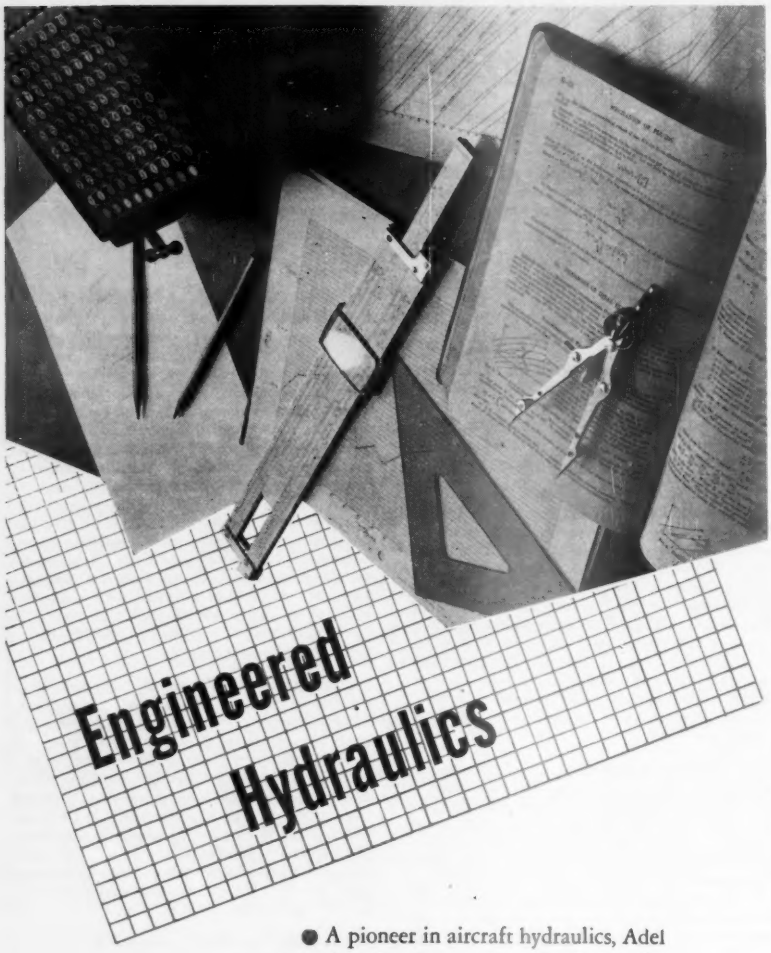
921. Aeronautical Engineer—M. S. from University of Michigan. Five years of teaching, followed by 12 years with two companies as aerodynamics engineer. Most of experience in aerodynamic development of high-speed military aircraft and, in the past 2 years of pilotless aircraft.

920. Aeronautical Engineer—Wind-Tunnel Assistantship and M.S. in Aeronautics, Cal Tech. Nine years' experience all phases of aerodynamics including performance, stability, flight-test, preliminary design. Specializing in wind-tunnel testing including model design, preparation of pro-



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grams, testing and tunnel operation, analysis of results, and company representation for aircraft and missile projects.

919. Industrial and Aeronautical Engineer—B.S. in Mechanical and Electrical Engineering; 2 years' postgraduate aeronautical engineering. Twenty-one years' naval aviator; wide experience operating, maintenance, and overhaul various types aircraft and engines. Retired as Commander, U.S.N. Four years' shop superintendent in factory manufacturing aircraft and aircraft engines. Five years' quality manager for one of the largest aircraft manufacturers. Desires position as quality manager or manufacturing executive.

916. Aeronautical Engineering Specialist—Age 26. Graduate engineer, mechanical major. Four years' experience government service as draftsman, design engineer in engineering, preliminary design, and design research divisions, Bureau of Aeronautics. Familiar with general design procedure. Knowledge of aviation, scientific, and naval affairs. Desires position as junior engineer; Washington representative (technical aide-engineering) for consulting engineers, research organizations, or Government contractors.

914. Flight Test Engineer—B.Ae.E. Age 32; married. Four years' experience in flight-test planning and analysis with high-performance military aircraft manufacturer. Responsible for several extensive research projects. Thoroughly familiar with the reduction of data obtained from complex automatic recording instruments.

913. Engineer—B.M.E. Graduate studies in mathematics and engineering. One year as assistant project engineer on automatic aircraft control. Two years in analysis of the dynamics of missiles and their control systems. One year in charge of design and operation of equipment employing electronic analogue computers for simulated flight test of actual missile control apparatus. One year in charge of analytic evaluation of missile guidance systems.

911. Management, Administration, or Sales—B.S. in M.E. Over 20 years' experience in aviation, incuding engineering, production, quality control, contacts, contract termination, materials, costs, and sales. Five years' research, N.A.C.A., hydrodynamics and aerodynamics. One year flight performance analysis. A and E mechanic; private pilot. Supervisory and administrative experience. Presently responsible for test and development of jet power plants at missile test center. Desires responsible position with young organization needing a versatile, well-informed executive. Prefers West Coast.

910. Aeronautical Engineer and Aviation Executive—Young, aggressive, responsible, full of initiative, with 15 years' experience, including 12 years aviation, 3 years nonaviation. Detailed aviation experience includes 9 years' aeronautical engineering in stress analysis, airplane structural design, testing, aerodynamics, supervision, and 3 years as top manager of aviation division (engineering and sales) of a large corporation. Also has acted as a consultant to U.S. Army Air Forces. Has actively participated in a responsible or key engineering position during the certification of eleven completed airplane projects (Army and civilian), and approximately 25 of a preliminary or partial nature. Thoroughly familiar with late Civil Aeronautics Administration Regulations in work as Assistant Chief of the Airframe and Equipment Engineering Division; B.S.M.E., University of Kansas, 1932; *Who's Who in Engineering;* and *Who's Who in Aviation.* Desires interview with responsible companies seeking top-drawer engineering talent and know-how to take charge of engineering and/or management of aviation division or equivalent.

909. Physicist-Aerodynamicist-Thermodynamicist—Ten years of diverse experience in the aircraft and gas-turbine fields. Has done internationally recognized research. Desires new position, preferably on consulting basis.

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908. Power-Plant and Engine Accessory Designer—Graduate M.E., German university. Extensive design and testing experience. Fully conversant with engine layout and all phases of development. Considerable design and research background on fuel injection systems.

906. Management or Engineering—B.S. in A.E. Ten years' experience including teaching, aircraft stress analysis, and aircraft propellers. Six of these years as Assistant Chief Engineer and Chief Engineer in propellers. Will accept position in other fields as well as aircraft.

904. Aeronautical Engineer—M.S. in Ae.E. Five years' experience in field of aeroelasticity.

903. Public Relations Representative—Seven years' experience in the active promotion of aircraft and propellers by teaching; lecturing societies, industrial, and civic groups; preparing publicity programs and press releases and over 40 technical and trade articles and papers. Writer—Editor of 1947 First Award Winning Paper of Lincoln Arc Welding Foundation contest. Foreign experience (Europe) representing U.S. aircraft manufacturer. Member U.S. T.I.I.C. team which explored German industry and returned latest developments to this country. Experienced in conducting plant tours, trade displays, civic, educational, press relations, and advertising agency liaison. Has had charge of entire program to introduce a unique mechanical product, educate the sales organization, and inform the trade and public. Desires position with manufacturer making finished mechanical products who requires the aggressive practice of public relations in the modern concept. Gas-turbine field of especial interest. Two years of college, 1 year of technical school. Age 29; married.

901. Aeronautical or Mechanical Engineer.—B.S. degree in Aeronautical Engineering. Graduate student for 1½ years in Aeronautics and Applied Mechanics. Two years' experience in the aircraft industry as a senior draftsman and aerodynamicist and other related engineering work. Will accept position anywhere in the U.S. or abroad.

900. Aeronautical Engineer—Age 36; married. Two and one-half years with major aircraft manufacturers as a specialist in weights and balance, technical writing, technical reports, and specifications writing. Able to handle and familiar with machine-shop practice. Holds a valid A. & E. license from the C.A.A. Has had approximately 12 years' all-around experience on transport and private-type aircraft as a technician. Would like position as technical reports writer, liaison and/or maintenance engineer.

899. Engineer—Housing requires a change of position this fall. Associate Professor, Aeronautical Engineering; age 32; large mid-western university. Technical Director of sponsored power-plant research project. Industry or university position considered. Rental housing for family of five a necessity.

898. Engineer—B. Aero. E., M. Aero. E. Three and one-half years' industrial experience, including over 2 years' aerodynamics in wind tunnel, performance, air loads, stability, and control. Past 1½ years as experimental research engineer with East Coast precision instrument corporation. Duties included design and operation of experimental equipment. Graduate studies include aerodynamics, both theoretical and applied, aviation gas turbines, stress analysis, dynamics of aircraft. Would prefer teaching position in New York area but will travel if necessary.

897. Associate Professor—Ph.D. in Applied Mechanics, degree in Aeronautical and Mechanical Engineering. Five years' experience in industry and research; head of structures department with aircraft manufacturer. Wishes to obtain university position teaching theoretical graduate courses in applied mechanics or mathematics, with opportunities for research.

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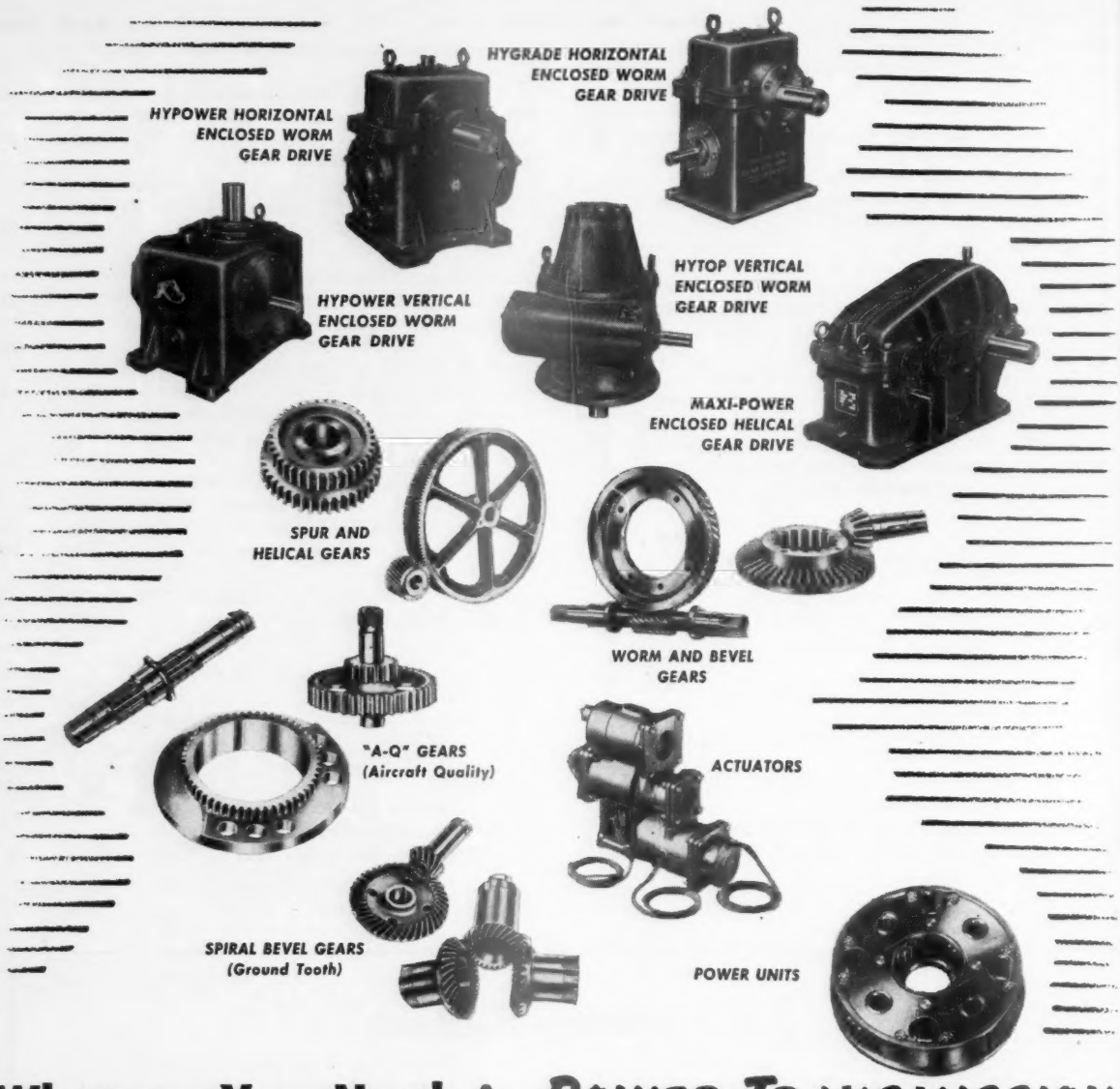
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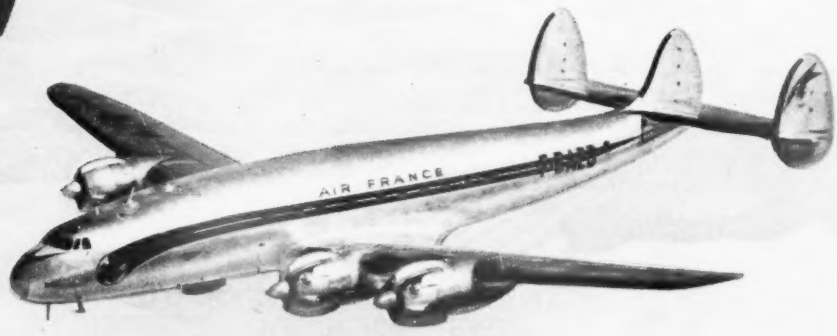

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